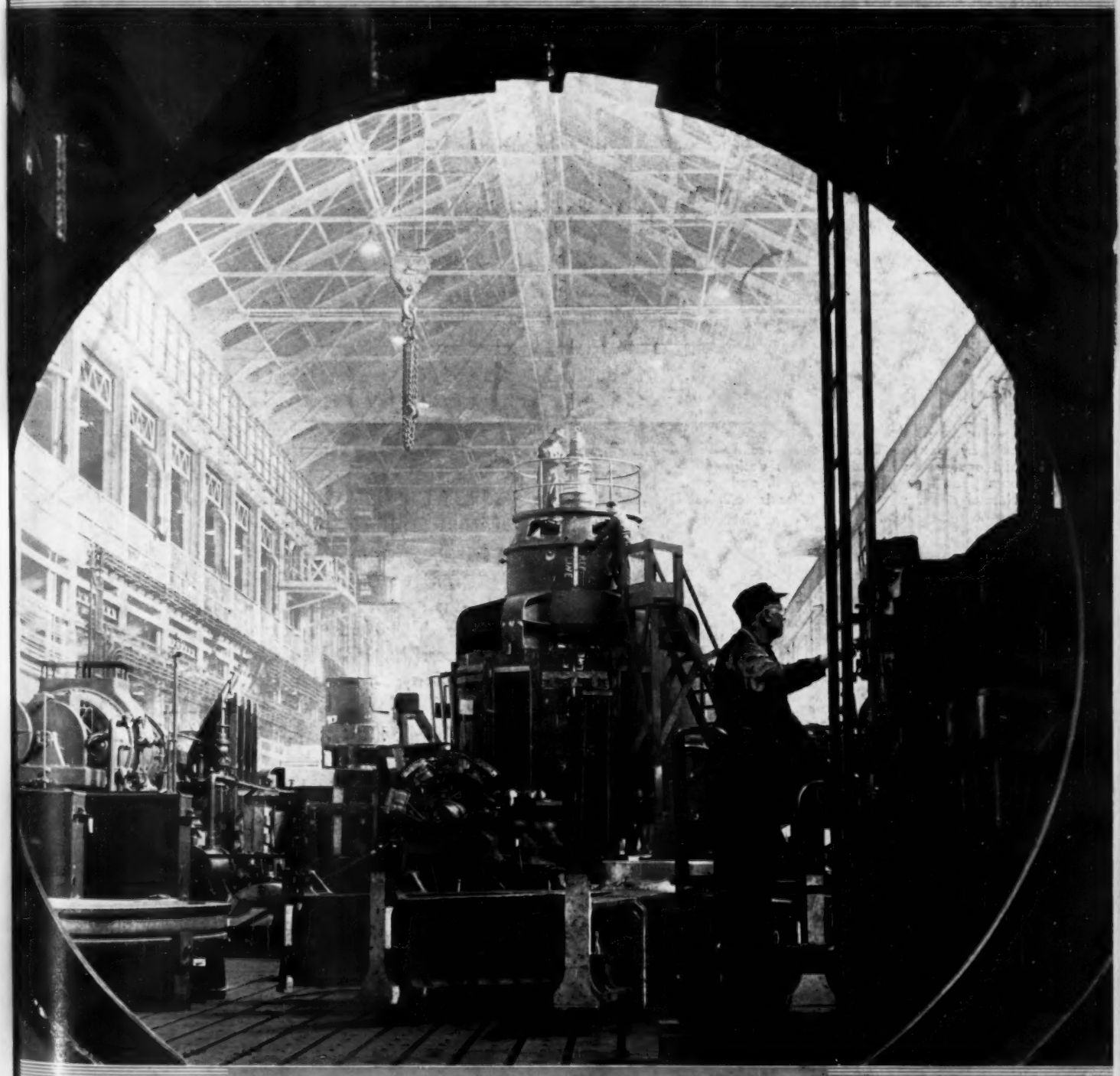
SEP 1 0 1945
INEERING
LIBRARY

MECHANICAL ENGINEERING



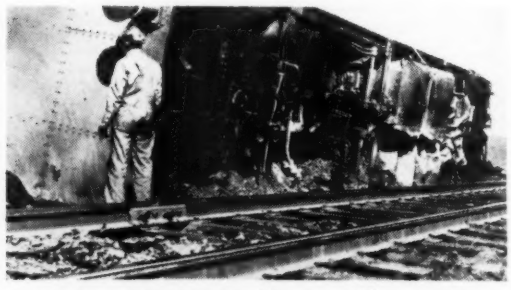
SEPTEMBER 1945

Lowering completely assembled B&W boiler into car of 1000 kw. mobile power plant. Boiler design is the popular B&W Integral-Furnace Boiler.

One of the 47 three-car, 1000-kw. power trains built by General Electric and Westinghouse, and equipped with B&W boilers designed to burn peat, lignite, low-grade coal, and wood. Normal steam capacity of boiler is 16,000 lb. per hour at 420 psi. and 730 F.

Furnace construction of B&W boilers used in mobile power plants. Neither sidewall tile, baffling, or front brickwork suffered cracks or other damage in derailed boiler car.

THEY EVEN SURVIVE WRECKS



unscheduled "test" proves sturdiness of B & W Boilers

AN ill wind, in the form of a railroad accident, recently produced spectacular evidence of B&W boiler sturdiness, in a "test" as convincing as any ever devised by our own test engineers.

En route to Russia coupled in a freight train, the boiler car of a 1000-kw. mobile power plant was derailed, dragged for a considerable distance, and turned on its side clear of the tracks.

Instead of being severely damaged as might be expected, when returned to the plant for inspection the boiler withstood the hydrostatic test pressure of 625 psi. without a leak. The furnace absorbed the jolt without damage. Neither sidewall tile, baffling, or front wall brickwork suffered a crack. Damage was confined to ash-pans and pipe connections under the car. The boiler survived its fall, stood up to every test—was soon on its way to its job of supplying steam power to devastated areas abroad!

At your disposal, on any problem involving steam generation or heat transfer equipment, are the B&W engineers and facilities whose products withstand such tests—the same organization that, for over 60 years, has led the trend in boiler design and workmanship: B&W designed and developed the first successful water-tube boiler; pioneered in the welding of boiler drums and in X-ray inspection of welds; has led in the development of high-pressure boilers, in conducting research in the creep of steel, and in developing improvements in equipment for producing clean, dry steam. B&W introduced the integral water-cooled furnace boiler, the Radiant, and Open-Pass boilers, and has pioneered in many other developments that have set today's boiler standards.

Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
85 LIBERTY STREET, NEW YORK 6, N.Y.

G-281

MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 67 NUMBER 9

Contents for September, 1945

THE COVER	*Manufacturing Aisle in East Pittsburgh Works of Westinghouse Electric Corporation*	
SCIENCE KNOCKS AT THE DOOR OF AMERICAN POLITICS	*M. L. Cooke*	569
AIR TRANSPORT COMMAND AIR-CARGO PROBLEMS	*H. R. Harris*	572
STUDIES ON THE MACHINABILITY OF CARBON AND ALLOY STEELS	*G. P. Witteman*	575
INCREASING PRODUCTIVE MACHINE TIME	*E. P. DeGarmo*	584
FLUID FLOW STUDY OF LOCOMOTIVE FIREBOX DESIGN	*Walter Leaf*	586
ENGINEERS INTO BATTLE	*T. A. Lowe*	591
OPERATING EXPERIENCE WITH THE GAS TURBINE	*A. E. Pew, Jr.*	594
VOLUMETRIC POURING MACHINE	*L. A. Quayle*	599
ON ENGINEERING WRITING	*D. M. Crawford*	607
MANAGEMENT RIGHTS AND COLLECTIVE BARGAINING	*Douglas McGregor*	610

EDITORIALS	567	A.S.M.E. BOILER CODE	617
COMMENTS ON PAPERS	612	A.S.M.E. NEWS	618
REVIEWS OF BOOKS	615	CONTENTS OF A.S.M.E. TRANSACTIONS	628

INDEX TO ADVERTISERS 150

OFFICERS OF THE SOCIETY:

ALEX D. BAILEY, *President*

K. W. JAPPE, *Treasurer* C. E. DAVIES, *Secretary*

PUBLICATIONS STAFF:

GEORGE A. STETSON, *Editor* FREDERICK LASK, *Advertising Mgr.*

K. W. CLENDINNING, *Managing Editor*

COMMITTEE ON PUBLICATIONS:

E. J. KATES, *Chairman*

L. N. ROWLEY, JR. H. L. DRYDEN

W. A. CARTER J. M. JURAN

ADVISORY MEMBERS OF THE COMMITTEE ON PUBLICATIONS:

N. C. EBAUGH, GAINESVILLE, FLA. HUNTER R. HUGHES, JR., DALLAS, TEXAS O. B. SCHIER, 2ND, NEW YORK, N. Y.

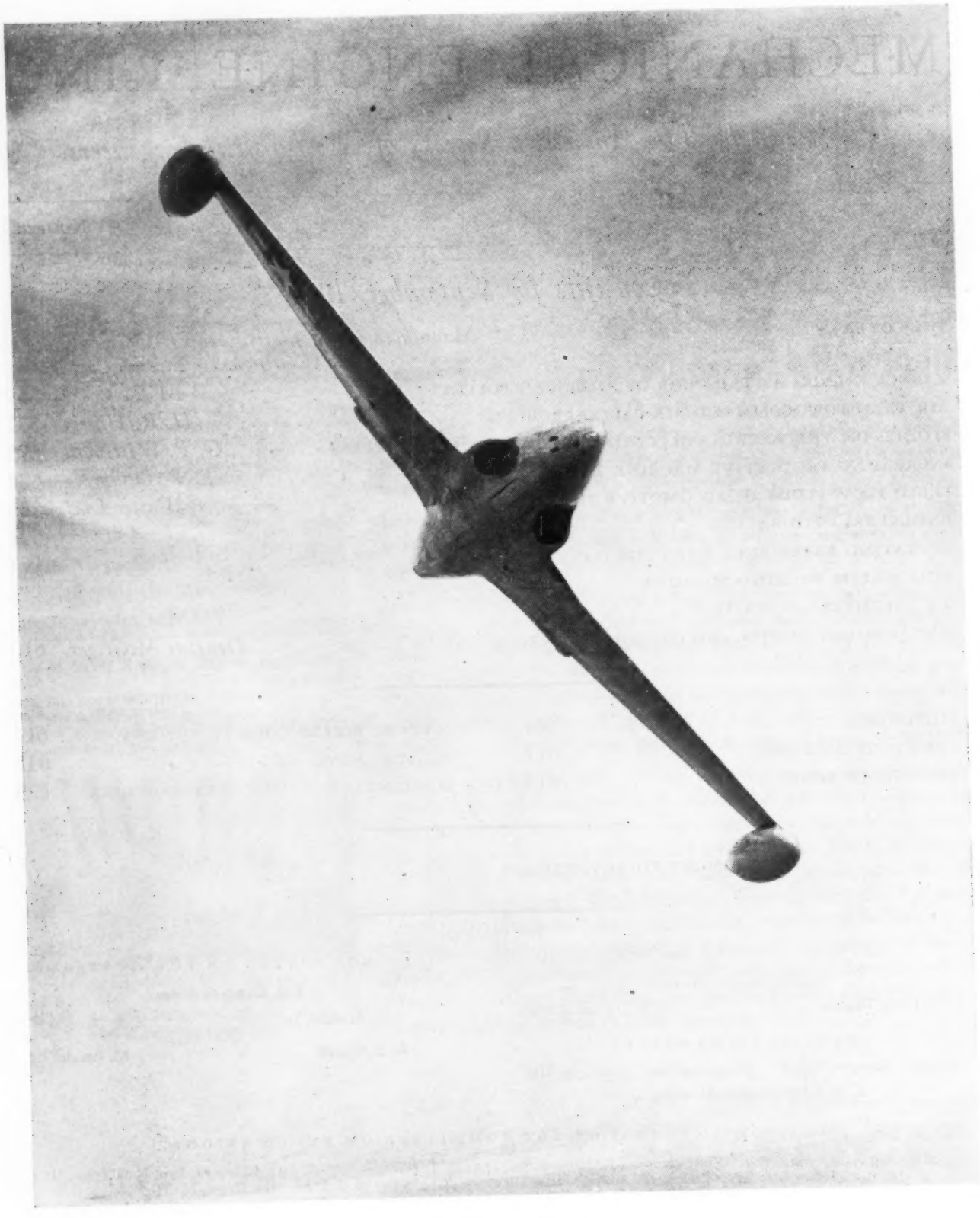
Junior Members: RICHARD S. BIDDLE, NEW YORK, N. Y.; JOSEPH M. SEXTON, NEW YORK, N. Y.

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price 75 cents a copy, $6.00 a year; to members and affiliates, 50 cents a copy, $4.00 a year. Postage outside of the United States of America, $1.50 additional. Changes of address must be received at Society headquarters two weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . .

Copyrighted, 1945, by The American Society of Mechanical Engineers

Member of the Audit Bureau of Circulations.

Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author, and that date of publication be stated.



"Shooting Star"

(Faired into extreme wing tips of the Lockheed jet-propelled fighter are auxiliary droppable fuel tanks that provide it with range sufficient to carry out missions now assigned to long-range conventional fighters. Twin air ducts that hug sides of the fuselage without marring the plane's aerodynamic streamlining draw air into the super jet-propulsion turbine located directly behind the cockpit. Location of the cockpit forward of the leading edge of the wing gives excellent pilot visibility. Center line of the wing is two inches behind the mid-point of the fuselage. The simplified G-E jet has but one moving part while the plane is in flight—the impeller and turbine connected by a shaft. The part spins at more than 10,000 revolutions per minute. The "Shooting Star" was developed with great speed under wartime pressure by teamwork of the Army's Air Technical Service Command at Wright Field and engineers of the Lockheed Aircraft Corporation and General Electric Company.)

MECHANICAL ENGINEERING

VOLUME 67
No. 9

SEPTEMBER
1945

GEORGE A. STETSON, *Editor*

A Few Short Weeks

IN the month that has elapsed since material for the August issue was prepared the news has been packed with events of far-reaching importance to the world and to engineering. Overshadowing all of these has been the surrender of the Japanese, hastened and made inevitable by the deadly atomic bomb and the entry of the U.S.S.R. into the war. Against the background of this stupendous change in the way of life and economy of all nations there stand, in sharp relief, the promise of a world without war, so earnestly planned at the San Francisco Conference, and the gigantic task of reconversion and reconstruction which must be a prelude to the attainment of that hoped-for end. For the accomplishment of this task the world will need a full measure of spiritual regeneration to assess human values correctly, humility to use the fruits of victory wisely, and patience and fortitude to implement the faith we hold that the world can live at peace, with freedom, opportunity, and justice for all. The sharpening of our moral focus and the broadening of our moral perspective must be some recompense for the sacrifices, both individual and communal, that the war has brought us.

On the material side too there are dividends yet to be counted. For purposes of destruction we have greatly advanced our means of production and have called to our aid science and research. We have revolutionized transport and communications over great distances. Only recently it has been revealed to us that the steady increase in the speed of airplanes has been enormously accelerated by the turbo-jet engine. Although the greatest speed made public is 550 miles per hour, it is permitted to speculate that much greater speeds are attainable, in anticipation of which the N.A.C.A. has built a supersonic wind tunnel. The makers of the *Shooting Star* speak hopefully of utilizing these astounding speeds in the transportation of passengers and freight. Many problems remain to be solved, but a generation which has witnessed the development of the jet engine, radar, and the atomic bomb will not hold further marvels too fantastic for hopeful consideration. Already the Gas Turbine Co-Ordinating Committee of The American Society of Mechanical Engineers is setting about to consider "how it can assist in utilizing atomic power to drive the gas turbine." One thinks inevitably of the electrical industry, an infant and almost a toy when the A.S.M.E. was organized, and how it has surpassed the wildest dreams of its proponents; of the automobile destined by its early critics to remain a rich man's plaything; of the radio that only an enthusiast content to wear a headset and put up with messages in the Morse code would bother with—these form a pattern if they do not point the way, and they remain to confound us.

Whether it be himself, those in his responsible charge, machines, or the forces of nature, in his ability to control, man rises to great heights of achievement. Thus while the world may view with misgiving, and something akin to horror, the devastating effects of the atomic bomb, the wise man will think of the scientists' opening of the Pandora's box of atomic forces in the light of what man has so many times accomplished when he has exercised wise control over the forces of nature that his growing store of knowledge has uncovered. One recalls the definition of engineering penned by Thomas Tredgold more than a century ago and still satisfying to intelligent men if not to lawyers—"the art of directing the great sources of power in nature for the use and convenience of man." This is the high calling of the engineer, in war and in peace; and it is not too much to hope that the engineer, guided by his brother scientist, will some day direct and control, for the use and convenience of his fellow men, this most recently available of all sources of power in nature, atomic energy. In that day his fellow men shall call him blessed; the chaotic birth of this new energy in the death and ruins of Hiroshima will stand as a historic fact and a warning to men of the uses and abuses of power; and to the human race itself will be bequeathed the responsibility of seeing to it that the tree of knowledge bears, not bitter, but wholesome fruit.

No more dramatic emphasis could be placed on the value and necessity of research than was done by the announcement of the atomic bomb close on the heels of the release of the report to the President on a program for postwar scientific research by Vannevar Bush, director of O.S.R.D., published under the title, "Science, the Endless Frontier." The appearance of this report is another significant event of the past few weeks. It had been hoped to present an analysis of this report, but space does not permit it in this issue. By now the report will have been read by a majority of engineers. A few years ago more persons would have questioned the wisdom of setting up a National Research Foundation than will question it today. The war has popularized research and has generated public confidence in its usefulness. The single example of the atomic bomb has proved to us that we must lead in research. It has given us a dramatic example of what the consequences of failing to be first might mean. It has also shown us what power research places in the hands of those who employ it and the developments that may spring out of it. Research is nationally vital, and research costs money.

More than twenty years ago Fred R. Low, in his A.S.M.E. presidential address, was thought by some to be too fantastic for an engineer by speculating on the possibility of releasing the power within the atom. In

his address he said that whoever succeeded in releasing this energy "may set off a train of decomposition that will cause the record of his achievement to be written on the firmament in a new star."

Engineers have no desire to establish a new star in the firmament through the destruction of the old world and its inhabitants. Their task is with the world as we know it and with the people as they exist. It is no easy task, albeit a glorious one. The road ahead is difficult—reconversion, reconstruction, full employment, high production, all to be carried out in the wake of war's destruction and in the face of changing philosophies of government and man's relationship to man. Hope and confidence center on the engineer whom the war has brought into his own. A few short weeks of history have brought us face to face with the immediate future. An epoch has passed; a new one begins—an epoch of difficult tasks. The first world war turned us from the role of a debtor to that of a creditor nation. The second world war leaves us the most powerful nation in the world. The engineer probably will not soon sit among the rulers, but he will control destiny in a considerable measure in his role of "directing the great sources of power in nature for the use and convenience of man."

High Production

SCIENTIFIC, engineering, and industrial achievements in prosecution of the war constitute a great American epic of high production and a demonstration of the virility and adaptability of a democracy many persons were reluctant to predict. It would be impossible to assemble the complete details of this great drama or to appraise the relative merits of every contribution in the race against time to provide the men and materials so urgently needed to protect a way of life that the individual prizes for his family and for the nation more highly than his own life or fortune. To have played any part, no matter how insignificant, in the current act of this great drama fills each of us with satisfaction dulled only by the regret that we might have played it more nobly or more intensely. These thoughts should strengthen our determination to perform the next act with even greater skill. Many of us learned that our part in the war was to exercise to the fullest extent toward a common vital objective the talents we had brought to bear on the individual tasks that filled the years of our lives prior to 1941. As we enter the years of reconstruction that must precede intelligent use of the fruits of victory, the demand on those same talents will be felt, and the obligation to exercise them to the best of our abilities will lie heavily upon us.

High rates of production were essential to the winning of the war; they will be no less important in reconstruction and the "winning of the peace." The destructiveness of war must be followed by the constructiveness of human pursuits to repair the damage and meet the needs of peaceful living. Although we must not neglect the spiritual regeneration of men and nations without which high standards of living breed envy and sow the seeds of war, many of us believe that the blessings of peace are highly prized by nations whose material welfare is secure. The freedoms for which we fought will not be less dear to us if we are decently fed, clothed, and housed and if the safeguards to health and opportunity and thought and education are strengthened. High production of hand and machine, of mind and laboratory, is needed for these things, and the war has given us examples of what high production means.

In this issue the story of one case of high production for the war—the loading of shells—is told in detail. Here "know-how" and ingenuity were relentlessly combined, as they have been in thousands of cases in peacetime and wartime, toward a specific end. Success in this case called for commendation, warmly given by Lieutenant General L. H. Campbell, Jr., Chief of Ordnance, in a letter to Mr. E. E. Ware, manager, Illinois Ordnance Plant. "The successful operation of this method of loading," wrote General Campbell, "is a great advancement and the most progressive step in the loading industry which has occurred during this present war. Great credit is due you and the members of your organization for the successful engineering of this design. . . . This improved process is all the more significant in view of the increased demands for artillery ammunition which come at a time of great shortage in available labor. It is estimated that in 1945 this procedure will save 4,900,000 man-hours—a truly great saving!"

Engineers are convinced of the value of high production. It is part of their fundamental philosophy. Because of it, with their ingenuity and "know-how" they have performed in wartime the great feats of which this single example is typical. With the confidence and backing of their fellow citizens, engineers will continue, in the reconstruction period and in the years of peace to follow, to demonstrate that high production is essential to human progress.

Engineers Into Battle

COLONEL LOWE'S article, "Engineers Into Battle," in this issue describes the British organization for repair and recovery of the tremendously complicated gear used by armies in modern war. This should be read in comparison with the article by General MacMorland in MECHANICAL ENGINEERING for November, 1943, "Weapon Maintenance in Battle," which described the American organization.

In the American military scheme the Ordnance Department has complete responsibility for weapons, tanks, vehicles, and the matériel generally described as ordnance, including the development, procurement, supply, and maintenance thereof, and the training of Ordnance troops for field maintenance. The Signal Corps has a similar responsibility for communication devices. This complete responsibility from the earliest stages of development until the item reaches the scrap pile insures the reflection of battle experience in modified designs and it puts supply of spare parts and maintenance under one field head. This is very important. In the British scheme one agency designs the weapons, another agency buys them, a third supplies them to the troops and furnishes spare parts, and the fourth, in this case the R.E.M.E., maintains the equipment in the field. Both methods have resulted in excellent field maintenance.—C.E.D.

SCIENCE KNOCKS *at the* DOOR *of* AMERICAN POLITICS

By MORRIS L. COOKE

CONSULTING ENGINEER, PHILADELPHIA, PA. FELLOW A.S.M.E.

SCIENTISTS will be the first to admit that all is not well in the current relations between science and politics. There is little of understanding on either side. To put it bluntly, the politician pretty largely ignores the scientist and the latter all but despises the politician.

Science, and engineering too, are at an all-time peak performance. In fact our technological advance has become so rapid that unless we drastically alter some of our social and political concepts and the institutions through which they are given expression, technological achievements by their misuse may actually be our undoing. In spite of glamorous accomplishments of science, it is apparent that for the greater part of humanity we have the specter of dire and growing want in the midst of potential plenty. For fast-moving progress along a broad front, the active and comprehending co-operation of politicians is absolutely requisite. So if there is anything which engineers and scientists can do to woo and win the politicians, the doing of it will have tremendous social significance. But it will be futile to knock at the door of American politics unless we come equipped with both understanding and sympathy. Some common ground between the two areas must be found. This, however, should not be too difficult.

Whether we like it or not—and some of us technologists don't like it at all—we are part and parcel of a community the life of which grows more complicated day by day, with increasing interdependence of the various factors and an ever-mounting toll which the public pays for inefficient or antisocial management of these public and quasi-public affairs.

Only to suggest their range—any complete listing would be impossible—I suggest the school system, civil liberties, labor unions; social agencies such as housing, hospitals, and boys' clubs; the co-operative movement, legislation and its improvement; and last but by no means least, party politics. From all this the normal scientist and engineer holds himself quite aloof. Of course there have been—and doubtless still are—a great many exceptions to this general statement as, for instance, Civil Engineer Louis R. Ash of whom the *Kansas City Star* said: "Every genuine movement for municipal progress had his support. Some have been successful and some have failed, but Mr. Ash never lost his zeal for better standards of government. In his death the city loses an individual backer in courageous civic efforts."

But even if there were thousands within our professions community-minded and active in community affairs, at best it would represent a negligible percentage of the total.

The rather invidious term "ivory tower" is largely a carry-over from the days when advances in human knowledge resulted from the labors of individuals isolated in most ways from the world outside their monastic cells. Notwithstanding the fact that science and engineering steadily acquire a larger place in our modern civilization, they all but unknowingly practice a form of isolationism which retards social progress and keeps us in many ways from realizing on the American dream of Thomas Jefferson—"a people living in comfort on the fruits of their industry." These callings are still pursued in an atmosphere of fairly complete detachment from that outside world wherein popular support for myriad causes rises and falls by turns and in so doing maps the course for the future of mankind. The modern "ivory tower" bears about the same relation to its ancient prototype as the Pentagon does to a one-time Army post in the Indian country. The quiet searcher after truth of ancient times has been succeeded by a personnel numbering hundreds of thousands included in a complex of technical organizations and organizations within organizations, the members of which contribute their best to thousands of discussions and publications, some of which are devoted to pinpoint specialties.

What is the basis for this holding aloof from the hurly-burly of American life? Certainly some of it—especially on the part of scientists—comes about through following a tradition. The student historically was a recluse. Then it is much more comfortable to live and move and have your being in 'a world where the fact stays put, recurs, and can be weighed and measured,' even though "most of the activities of men are carried on in a world of uncertainty."[1] Then if one is sensitive to criticism, answers derived by means of slide rules and test tubes certainly provide a defense for which one need not apologize. By contrast, statesmen—or politicians if you want to call them that—are apt to respond rather blithely to criticism. An Alfred Emanuel Smith, or either of the Roosevelts, or Gifford Pinchot, or Winston Churchill, if told of criticism, would quite likely take it as a sign of accomplishment, and smiling, possibly remark, "We seem to be getting some clothes out on the line."

Only recently have we begun to have anything approximating a statistical demonstration of the attitude of scientists and engineers toward the great world of men and affairs lying outside the boundaries of their professional interests. Among 200 top-grade members of the major engineering societies living in a large eastern city, only four were found to be associated with the management of its quasi-public social activities, such as hospitals, family welfare, symphonic music, housing, and homes for the aged and children. Among another 200, only two were associated with the annual welfare drive for their financial support.

Among over 100 rather outstanding citizens associated with the management of the American Civil Liberties Union, there is one engineer and one scientist. Among over 300 scientists and engineers belonging to a distinguished social organization choosing a considerable part of its membership with some care from among these groups, only five were found to be associated with social agencies.

Notwithstanding that peace is the world's most absorbing concern, the lists of those responsible for the management of local and national agencies seeking to promote the cause of peace indicate almost no participation by engineers or scientists. Among the nearly 200 names on the board of directors and the National Committee of Americans United, our most

An address delivered at a Conference of the Arts, Sciences, and Professions in the Postwar World held at the Hotel Waldorf-Astoria, New York, N. Y., June 22–23, 1945, under the auspices of the Independent Citizens' Committee of the Arts, Sciences, and Professions. Mr. Cooke acted as chairman of the Science and Technology Panel.

[1] "Education for Responsible Living," by Wallace B. Donham, Harvard University Press, Cambridge, 1944.

representative and inclusive organization working for peace, no member of either group is to be found.

An even more significant indication of our absorption in our own technical affairs is the fact that among over 40 organizations selected to aid our Government during the present United Nations Conference at San Francisco, "scientific and engineering groups are totally absent." These groups comprise religious, educational, labor, legal, agricultural, racial, business, and social organizations, and the latter include Rotary, Kiwanis, and Lions. There is not one engineer or scientist among about 400 individual consultants and advisers officially chosen from among a wide variety of callings, seeking to do their bit at San Francisco.

One wonders whether Maurice Maeterlinck with poetic intuition may not have had this situation somewhat in mind in his description of "The Kingdom of the Future" in his beautiful fairy play, "The Blue Bird." The children who are yet to be born are milling around in the halls of the Azure Palace, the doors of which open out upon actual life and the quays of the Dawn. Just as one contingent of these youngsters is about to shove off, the whole assemblage is startled as Father Time calls out: "Where are the Engineers?"

To be completely fair to these distinguished professions it should be stated that there would be no holding back should their assistance at any time be requested by duly accredited public agencies. This has been repeatedly demonstrated during the course of the war. Unfortunately it is also true that there have been instances—some of them quite recent—where we have taken the initiative in tendering our good offices and they have been declined. Frankly, as professions we are not held by those in the seats of authority to be so conditioned through contacts with the great big nontechnical world as to make us available for a wide variety of services to the public. One is led to ask whether scientists and engineers realize the size and pulsating character of the world which lies entirely outside their own particular technical fields.

Twenty years ago a committee of the Iowa Engineering Society said that the only effective way for engineers to get public recognition is for the individual "to adopt the viewpoint of a citizen and work as a citizen of his community. . . . So long as the engineer confines his efforts wholly to his technical work as an engineer, the public cannot know much about him."

In commenting on this statement the *Engineering News Record*[2] said:

> When the public has a satisfactory experience with one engineer as a fellow citizen it is inclined to think well of engineers in general; when it sees one engineer achieve leadership in his community, it is inclined to look upon the engineer in the abstract as having the stuff of which leaders are made. The committee is on sound ground also when it expresses its belief that some of the qualities of leadership, now potentially in engineers as a class, must be developed and strengthened before they will be ready to play their full part in public affairs. That development can come mainly through development of the individual, and that in turn can come best through his individual participation in public affairs as a citizen possessing peculiar abilities to be of service to his fellows.

Evidently we need a more extended companionship. To bring it about should be our passionate concern if we are to live adequately in these fateful times.

Promising remedial measures must be based, among other considerations, on an accurate understanding of the engineer's and scientist's attitude toward politics and politicians. To avoid any impression that I am an apologist for what is untoward in American politics, I may say that on frequent public occasions since coming of voting age I have poignantly bemoaned its low moral tone. I bitterly resent the fact that what Lord Bryce said of my home city 50 years ago is still essentially true: "The most dangerous enemies of reform have not been the ignorant and the poor but men of wealth, of high social position and character." And yet, having had the most ample opportunity to observe politicians at all levels in action, I am disposed to agree with Claude Bowers, distinguished editor, biographer of Thomas Jefferson, and now American Ambassador to Chile, in feeling that on the average they are no worse than other men, perhaps of a somewhat higher caliber.

Our engineering and scientific groups I believe hardly realize that our political hierarchy including township, county, city, state, and national government is the basic structure—good, bad, or indifferent as the case may be—which supports our whole social system. Our groups look upon government rather as excess baggage which possibly may come in handy in emergencies. The engineer, salaried employee as he usually is, is tempted to take the big business point of view which encourages the public to attach undue significance to voting and to other political devices, while back of this front those with no public responsibility pull the vital strings.[3]

On the other hand, the true devotee of science obtaining from his work a large measure of release from normal worries—comfort somewhat comparable to that afforded by religion—would like to ignore politics completely, were it not for the necessity of securing appropriations from time to time. I suggest we struggle to accept as wholeheartedly as we can our political system on the same grounds that Thomas Carlyle gave for Margaret Fuller's acceptance of the universe, "By Gad, she'd better."

A further hurdle appears to lie in our attitude toward the individual politician. He is much more nearly like ourselves than we think him to be. Allowing a bit for possible differences in the educational level, the politicians with whom engineers and scientists would normally co-operate to mutual advantage will doubtless show about the same variations in integrity, understanding, and desire to be useful as are usually found either on the campus or in a business concern. "Most politicians have to live in a goldfish bowl. Their acts can be scrutinized, criticized, and often are misrepresented in a fashion that would give the average businessman a nervous breakdown. The politician's mistakes stand out; his virtues are apt to be forgotten."[4] In spite of all the difficulties, the great causes represented by science and engineering will be advanced if as many individuals in these groups as possible get to know and keep close to one or more public officials. This will constitute a major stroke in breaking down the bulkhead which separates science and politics. It is because the scientist today is essentially without access to the political mentality that many messages full of deep meaning for the people never reach the action stage in any large way. There are questions as to soil and water conservation, health, nutrition, industrial relations, comity between nations, higher and wholly feasible standards of living, necessity for fundamental physical and biological researches upon which there is practically no difference of opinion among us, but on which public action lags.

With no desire to leave a word unsaid in deprecating the illicit in machine politics, still it must be admitted that the machinery itself is necessary and can be used and is used, more frequently than not, to advance desirable social ends. Very few public causes get beyond the dream stage until there has been created an organization to push them. Even the continuity of policy in a college faculty is aided and abetted by

[2] Issue of April 26, 1923.

[3] For instance, Lammot du Pont writing to Lord McGowan, head of Imperial Chemical Industry (Great Britain) in July 1933 said: "If any legislation on international agreements is brought about which affect these I.C.I.-du Pont relations, I am sure we will be able to adjust ourselves so as to get the continued benefit of our agreement." This was in answer to a letter from Lord McGowan urging that something be "done to insure that no prospective political or legislative action on the part of governments" be allowed to change the relations between the two companies.

[4] *Philadelphia Record*, June 3, 1945.

line-ups sometimes not visible to the naked eye. So our duty as citizens is not to tear down political machinery but rather to do our part—usually a very little part—in making it function in a socially desirable manner. Too many of us are dissuaded from doing the little we can in this and other important matters—voting, for instance—by this realization of how relatively unimportant our effort may be in the whole picture.

Important as is the discriminating evaluation of the American political system and of the individual politicians who operate it, even more so is the task of bringing scientists and engineers actively into the life and service of the community along lines having little or no relation to their professional activities. In the most recent authoritative study of the engineering profession[5] we are enjoined in one place "to advance philanthropy, man welfare activities, serve as trustees, and lead civic movements," and in another, to make "creative contributions as statesmen, thinkers, artists, philanthropists, and leaders of social movements." Another recognized authority tells engineers to serve "by expert counsel in their field by participating as civic leaders in community enterprises."[6]

The basic idea here appears twofold: First, that our specialized engineering knowledge is to be the basis of our services; and, second, that for some unexplained reason we go into places of leadership without serving in the lower ranks first. Should these pronouncements be shown to a typical American politician he would probably remark with complete indifference either "So what?" or "How come?" I am reminded that my mother was anxious for me to enter the ministry. But I doubt if she ever pictured me as a divinity student, candidate for orders, deacon, or plain minister. What I think she really wanted in the family was a bishop. Somebody has got to operate the community with its modern complex of interests and activities, and this whether the community under consideration be a small village or the nation as a whole. With the problem clearly before them, scientists and engineers will not want to claim exemption. They do not want to be classed as civic conscientious objectors.

There are some fairly unimportant tasks, both public and nonpublic, to be performed in the adequate conduct of our modern communities, made possible so largely through the ministrations of science and engineering. For instance, on the local political side someone has to pull doorbells in order to get out the vote. Officials and watchers are needed at the polls. Sooner or later anyone who has an ambition to lead in high political place had better stand for a minor local office. There is a might of education to be obtained in so doing. There is an old saying that an Englishman can never become prime minister unless he has carried his home election district. To carry on a campaign for even a minor change in legislation frequently requires the devoted service of a lot of people in minor capacities, sometimes carried on through many years. But this is a part of the price we pay for our highly prized democracy.

In the surgeon's code, laziness is made unprofessional on the ground that a lazy surgeon cannot keep up with what is known, and without this knowledge his best service to the patient is impossible. Somewhat similarly I believe we should have in the code of the scientist and the engineer provision that a practitioner of either calling must perform some community service not related to his profession. This would be on the ground that both scientists and engineers must be good citizens and this involves some assumption of community responsibility. Through appropriate channels we could very quickly pass the word to the world beyond our own absorbing professional interests that we seek outlets for whatever community-mindedness there is among us. I would expect that the response would be immediate and widespread, and that gradually through the years our aloofness might become only a memory.

Of course, in the long run, education provides the only answer to most fundamental questions. How to inculcate this sense of responsibility to the community in science and engineering students is a task for educators, once the problem is recognized. The student must not only have "a knowledge of social and human relationships, an understanding of the duties of citizenship"[7] but he must be led—I believe even in school and college days—actually so to perform. Teachers taking an interest in civic affairs would certainly influence students. Popular Ike Sharpless, one of Haverford's greatest presidents, always made the effort to have a public job in township, county, or state as an example. We may have to educate the educators.

At a certain girls' school in Virginia—patronized by the very well-to-do—the enlightened principal insists that each student as she matriculates choose some community service in the near-by town to which she will not only devote so many hours each week, but also regularly contribute to its financial support. If I were a college president I would arrange that every freshman planning a scientific or engineering career should put in a stipulated amount of time on community activities—perhaps as a runner for a hospital, in doorbell pulling for a political party,[8] making surveys for the town council, soliciting for the welfare drive—in some activity, preferably one of his own choosing. The political science and sociology departments could well use such services.

If we were completely satisfied with the way our democracy works and if we could detect no threats to the smooth functioning of our social economy, we might well lay this concern on the table. But recent events prove that we must ignore no safeguards. To think out methods for breaking down the barriers which separate science and engineering from the whole life of the community must of necessity be a perfectly logical interest for this Panel of our Independent Citizens' Committee, for only thus can science through Politics become dominant in the affairs of mankind.

I INTERPRET life as a dynamic state of organized matter in which energy is not dissipated, but stepped up thus preserving the balance of energy in the universe and preventing its running down. I see a possibility of choice due to what is now called the uncertainty principle and what I spoke of many years ago in my paper on the freedom of the will as the principle of plural effects. I try to interpret as good any action which tends to preserve the balance of energy in the world, and as evil any action which works in dissipating it. . . . . I draw the conclusion from these fundamental principles that choice being possible and subject to the guidance of our conscious mind, we are responsible for our actions whenever our mind is capable of evaluating the alternatives.

Personally I am inclined to think that the forces which manifest themselves in living organisms and differ from those known at present to physics are nevertheless physical in nature and subject to natural laws supplementing, rather than setting aside, other natural laws. The time may come when those forces may be known and the mystery of life will be solved. Until that is accomplished, science would be unjustified in any attempt to substitute faulty reasoning engendering doubt for the calm assurance of religious faith.—Alexander Petrunkevitch in "The Controversy of Faith Versus Reason," *American Scientist*, July, 1945, page 189.

---

[5] Report of Committee on Engineering Education After the War, *Journal of Engineering Education*, vol. 34, 1944, and MECHANICAL ENGINEERING, vol. 66, 1944, pp. 403–412.

[6] "The Engineering Profession Tomorrow," by Robert E. Doherty, president, Carnegie Institute of Technology, MECHANICAL ENGINEERING, vol. 66, 1944, pp. 602–604.

[7] See reference 5.

[8] In years gone by I used college students in large numbers to do political canvassing and paid them well out of party funds for the service.

Air Transport Command

AIR-CARGO PROBLEMS

By BRIG. GENERAL H. R. HARRIS

CHIEF OF STAFF, U. S. ARMY AIR TRANSPORT COMMAND, WASHINGTON, D. C.

IT was about three years ago that the organization now known as the Air Transport Command embarked upon its career of handling air freight in ever-increasing quantities.

Until that time, with the exception of a few isolated instances in remote parts of the world, there had never really been any air freight as we know it today in the routine business of supplying the Army establishments in the far-flung corners of the world.

PASSENGER PLANES ADAPTED TO TRANSPORT CARGO

Suddenly the Air Transport Command was confronted with the problem of moving real freight; freight that ranged in size from a tiny package of machine screws to the fuselage of an airplane, or Diesel generator sets weighing 4 tons or more. The aircraft in which we were forced to carry this freight at the beginning had been designed primarily as passenger aircraft or for tactical purposes, and were conversions.

In the process of such conversion, all too often the matters of interior design, size of doors, type of floor, and provisions for securing loads were either forgotten, or if not forgotten, represented the ideas of a great many individuals who had had no previous experience in the transportation of very heavy cargo by air.

The results at first were far from encouraging. A DC-3 with ample cabin space to accommodate freight of considerable cubage would, as often as not, be handicapped by a door through which it was difficult to pass a well-filled mail bag. On the other hand, converted bombers quite frequently presented the opposite problem, that of a door through which an incautious GI might well drive a 6 × 6 truck, and with cabin space designed primarily for the high density, low cubage of bombs.

Ground handling equipment and methods were equally primitive and ranged from a line of negro bearers to huge crash trucks with $8\frac{1}{2}$-ton prime movers. In no case was the size of cargo or the door height anywhere nearly in approximation with the top of the bearer's head or the bed of the truck. Freight was either laboriously handed up or precariously lowered into the cabin. All this involved manpower, lots of it, and far more time than was available to be spent on the ground. Airplanes move no freight on the loading ramp.

To complicate the situation still further, aircraft designers began to come forward with new airplanes designed primarily for the transportation of air freight. These were designed well in all but one respect; and reference is made here to the well-known reliable giant of the Air Transport Command, the DC-4 or C-54 as it is known. It was early discovered that on this otherwise excellent airplane, the loading door was located some four or five feet above the reach of the normal man or his truck. As a result, heavy equipment, ammunition, and large crates simply would not lend themselves to being handled manually.

Meanwhile, a great many temporary loading expedients had been put into use, among them electric cranes, warehouse-type fork lifts and platforms which were set up alongside the aircraft and provided a staircase effect up which freight might be manhandled, but none of these expedients was the complete answer. Cranes were too slow and involved the placing of slings around each piece of freight in order to swing it into place and as frequently as not, succeeded in carrying away the upper part of the door while attempting to swing the freight into the cabin; warehouse fork trucks, with their great weight and small hard rubber tires, were prone to sink to the crankcase in the mud and sand of early fields; and loading stages were slow of erection and even slower in loading.

In spite of unquestioned advantages, the use of power conveyer equipment was virtually precluded by the limitations placed upon the capacity of this type of loading device.

In addition, whatever equipment was designed must of necessity be capable of being itself air-carried, since at this stage of the war Air Transport Command was, as often as not, the only means of transportation into many of the fields being operated.

SOMETHING NEW IN CARGO-HANDLING MACHINES

As a solution to this problem, in collaboration with a large manufacturer of material-handling equipment, a hybrid was designed which combined the hoisting features of the fork lift with the power, speed, and flotation of a large pneumatic-tired truck. This somewhat odd-appearing machine was readily disassembled into three major units and driven aboard an airplane under its own power, so that it could immediately be placed in operation at even the most advanced points. Used with bins which held a large bite of the load, and able to serve as its own tractor, this machine pulled loads to planeside and then picked them up and placed them, not alongside the airplane, but actually inside the cabin. Today, it is performing an excellent job on every field throughout the Air Transport Command's world-wide system.

As a consequence, the C-54 and C-46 are now rapidly loaded with freight ranging from 20-lb bags of mail to large aircraft engines on dollys, power equipment, ordnance, and every variety of heavy freight. As a corollary, of course, the unloading operation has been simplified and speeded up to the same degree.

Later, for those fields where only a few aircraft were loaded at a time, the versatile 6 × 6 "Jimmy" or $2\frac{1}{2}$-ton, six-wheel-drive truck, was fitted with a body which could be raised to any door height up to 12 ft. This made it possible to carry an entire load to planeside and work it aboard much as though the airplane itself had been brought alongside a loading dock. While not quite so rapid in the handling of heavy freight and possessed of the inherent disadvantage of requiring one or more trucks for each airplane to be loaded, this type of vehicle has, in a somewhat more limited and specialized fashion, proved very useful in Air Transport operations.

Equipped with these two devices and bolstered by a score or more of trailers, roller-conveyer sections, and other equipment

Presented at a Joint Meeting of the Aviation and Materials Handling Divisions, New York, N. Y., March 12, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

which were almost daily developed to expedite its work, the Air Transport Command is able to rapidly load and unload aircraft of virtually any type foreseen in the near future, and to handle freight of any dimension or weight which can be loaded in those aircraft.

TYPES OF AIR CARGO HANDLED

From the standpoint of traffic movement and handling, air cargo falls into several classes. Heavy bulky pieces constitute one of the principal problems. Aircraft engines, oil drums, barrels of cement, jeeps, bulldozers, fork lifts, and other heavy machinery and parts are difficult to handle.

Next to heavy cargo, odd-shaped pieces cause the most concern. These are not so hard to move into the airplane but immediately, a stowage problem is presented. Steel pipe and bars, propeller blades, aircraft cowling, turrets, wing tips, ailerons, and strategic materials in sacks are awkward to stow and tie down. Frequently, great bulk and lack of weight are the principal problems, and this type of cargo is difficult or impossible to stack.

Fortunately, the greater portion of air cargo can be packed in containers of conventional size and shape. Most of these pieces can be moved and lifted by hand which makes for quick and efficient loading. Heavier pieces are, of course, placed on the bottom of the pile, and stacking makes possible efficient use of cabin space. Most aircraft and automotive parts, food, and general supplies of all types, together with some strategic materials moving back to the United States, fall into this classification.

Some cargo requires special handling and attention. Explosives and acid require particular care in stowing and tie-down to insure against landing, take-off, and rough air shocks which may result in shifting. Serums and other types of medical supplies require icing or other special handling.

EVOLUTION OF AIR-FREIGHT PACKING METHODS

Let us go back for a moment to the summer of 1942, when it became known that a great many temporary structures were being erected overseas using crating lumber removed from shipments which had been flown across the ocean by air. Now crating lumber, at best, has little if any, intrinsic value for re-use, and the thought of transporting it many thousands of miles at high cost by air, when it was the material inside the box that was vitally needed, was enough to give pause to the most optimistic advocate of air freight.

Research began immediately, and has continued upon the matter of just how much, if any, packing is needed for air transportation. Several factors dictated a minimum of packing; that is, aside from the paramount one of the saving of valuable weight and space for the cargo itself rather than for nonessential packing material. For one thing, air freight rarely, if ever, spends several weeks in the open on a dock awaiting the loading of freight car or steamship. It moves fast, and protection against the weather is therefore limited to the prevention of damage to the material over a short period of time.

Air freight, again, is not handled as roughly as freight shipped by surface means. The structure of the airplane itself precludes throwing, dropping, and general manhandling of freight when being loaded or unloaded. Added to these points is the importance of air freight. Everyone, freight handlers included, realizes that the shipment he is handling must be quite a vital piece of material or it would never have been sent by air in the first place. This general feeling contributes to better handling than is customary in other forms of transportation.

Approached in this light, the extremely heavy packing, using a great deal of lumber such as is customary for shipments which must be lowered in slings into the holds of cargo vessels and which may bear the weight of many tiers of freight stacked on them in their hold, is completely unnecessary. The education of shippers in the use of lightweight packing materials notably the V-grade weatherproof fiber containers and light plywood crating, was a difficult task at best. Air transportation represents a relatively small portion of the material being shipped overseas, and a great deal of inertia was encountered when special preparation for shipments by air was requested.

Realizing that this education might well continue through the course of the war before concrete results were obtainable, the Air Transport Command instituted a new departure in freight handling, the repacking by the carrier of freight which should have been properly packed by the shipper in the first place. This activity requires much in the way of material and personnel, but the results have proved startling. For example, in three months repacking for air shipment effected a weight saving of 1,627,500 lb. Resolving this saving into pay load, it represents approximately 400 trips carrying real freight instead of lumber. If we assume an average freight distance of some 2000 miles, this weight saving represented 1,628,000 ton-miles. Figured at 10 cents per ton-mile, we saved in three months better than $162,000. Spread this over the entire period of operation and the saving resulting from repacking is considerable.

Recently the results of attempting to make the shippers realize the saving to themselves by the use of lighter packing have begun to bear fruit, as is witnessed by the gradual reduction in the number of shipments which must be repacked, coupled with an equally gradual increase in shipments arriving at the Port of Aerial Embarkation properly packed for maximum protection and minimum weight.

EFFICIENT LOADING OF TRANSPORT AIRCRAFT

Proper and efficient loading of transport aircraft is a major problem demanding close attention to several factors. The initial selection of the cargo to be loaded requires study and experience. Both bulk and weight must be considered. Except in an emergency, a load would not be constructed entirely of heavy ammunition with small bulk, or of awkward engine cowlings representing large bulk and lightweight. Proper utilization of the cabin area and maximum pay load demands a selection of assorted cargo comprising both weight and bulk.

Once the load is selected, actual location of cargo within the cabin immediately brings weight and balance into play. Safety and efficient flight operation require that cargo be so placed within the cabin as to result in a perfectly balanced airplane in flight. The center of gravity is, of course, the determining factor and varies with each type aircraft. A number of satisfactory systems have been devised to control the balancing of cabin loads and the Army Air Forces have standardized on one method.

A practical problem results from the need to quickly identify and locate cargo in the cabin after arrival at an intermediate destination. Because of the weight, bulk, and tie-down problems it is not always possible to arrange the cabin load by destinations for easy off-loading. Frequently, cargo for a further destination will have to be moved in order to off-load pieces at intermediate stops. This requires loading charts, reflecting both weight, balance, and location by destinations, and these may of necessity be frequently changed en route, as the load changes.

Accompanying these developments in the handling and processing of air freight, the "staff" must prepare the numerous records required, if freight is to be properly handled without loss, and in order that statistics on the operation may be available to those concerned with the management. Borrowing from the experience of the railroads, the steamship lines,

and the established transportation companies in this greatest of all transportation nations, a new system of paper work resembling, in some cases, its predecessor, but reduced to a minimum, was set up. This included the design and publication of a new airway bill, adapted to the military nature of the traffic, which would serve as an individual record of shipment, authority for that shipment to move, and as a basis of subsequent tracing and delivery records. Used with the "air lot label" on shipments consisting of more than one piece, it has reduced the initial paper work to a minimum. A new manifest was designed which provided a record of the movement of cargo. When used in conjunction with the airway-bill number and the in-transit record which is kept at transfer points, this manifest provided a step-by-step record of the movement of the individual shipment as well as a record of the cargo-carrying job done by the airplane. Delivery records maintained at destination points closed the books by establishing the fact that the Air Transport Command had performed its job and turned over to the consignee the shipment with which it had been entrusted.

SOLVING THE TIE-DOWN PROBLEM

While all this work was being carried on, a new problem had developed, and a very serious one. Reports began to trickle back of damage to aircraft caused by extremely heavy cargo which had worked loose during turbulent flight conditions and commenced to move about the interior, endangering the crew, and the safety of the plane itself.

Until this time cargo had been tied down to any projection which offered itself from bent nailheads to tie-down rings, by everything from builder's twine to anchor cable. At the destination the favorite unloading tool was a sharp knife which created a mass of short lengths of rope yarn.

A survey was conducted and it was determined that an average of nearly 200 lb of these useless rope ends had accumulated in virtually every cargo airplane, to the detriment of its pay load, and without offering any conceivable use in securing future loads. Since the rope-and-knot method was slow and unsafe except in the hands of a skilled boatswain's mate, the Air Transport Command, in conjunction with industry, undertook to design and use a new form of tie-down gear which has become known as "Skyloader" equipment. This equipment made use of mechanical leverage for taking the slack out of rope when used, and the principle of the automobile jack for restraining extremely heavy cargo. Such a method obviated the use of knots, thereby making possible the continued reuse of one length of good, sturdy rope, rather than the assortments of sash cord, builder's twine and 1-in. manila which had previously been the custom.

However, the best of tie-down equipment could do nothing if tie-down fittings and floors were not constructed to take the wear and tear of heavy cargo and to withstand the stress encountered during turbulence. In collaboration with engineers at Wright Field, much research was given to the design of tie-down fittings, their placement, and the type of flooring which would best handle heavy freight without the necessity for spending many hours in the shop repairing and replacing floors, as was the practice with the makeshift floors which had until then been the rule rather than the exception.

A design was finally approved which involved the use of aircraft plywood topped with aluminum skid strips to take the wear of skidding heavy cargo, as well as to make somewhat easier the job of the man doing the skidding. These skid strips were readily replaceable by unskilled labor and since they were the only wearing surface, tended to reduce greatly, if not almost eliminate, the time spent in floor maintenance. Tie-down fittings stressed to take the strain of heavy cargo, were placed on a standard grid pattern so that an ample number of fittings were available. Thus personnel concerned with loading might become familiar with tie-down location and more readily plan their loads. This floor is also receiving wide acceptance from the Navy since it is packaged as a replacement unit by the manufacturer and is readily installed as a modification in the field.

One project now worked out is of interest in connection with much of the foregoing. Flight-traffic clerks or so-called "supercargoes," are now part of the crew of an Air Transport Command transport. These soldiers are responsible for a great variety of functions, all directed toward greater efficiency, i.e., checking manifests, assisting with loading and unloading at intermediate points, supervising tie-downs, checking weight and balance, handling of passengers, and other duties. These men are invaluable in the solution of routine traffic-handling problems.

TRAFFIC-FLOW PROBLEMS

The ability of each A.T.C. route to move traffic obviously depends on the capacity of the aircraft operated per day, week, or month. To "feed" traffic into the air line at a rate directly related to the capacity of the route requires planning and control. The transportation demands of a global war fluctuate greatly and it would be hard to justify a world-wide air-transport system that had no traffic to move one day and a great accumulation a week later. The inherent urgency of war traffic demands a system flexible enough to make deliveries on dependable schedule wherever the exigencies of the tactical situation require.

Many interesting traffic-flow problems are involved in A.T.C. operations. On one route traffic is moved several thousand miles before encountering a long overwater flight which requires additional gas and consequent decrease in cabin load. The off-loaded cargo immediately forms a backlog and is subject to delay. This situation is handled with shuttle planes operating over the water jump in order that route capacity will be held constant through to destination.

On another route a different situation exists. A long overwater flight followed by shorter flights results in an increase in allowable cabin load. This situation also requires shuttle trips over the water hop to bring route traffic up to capacity for points beyond.

CONCLUSION

The foregoing are some of the problems concerned in military air-cargo transportation which is still in the development stage, facing new and difficult situations. However, statistics indicate that the system is actually working as attested by the fact that 402,000 tons of cargo alone were loaded and transported during 1944. During that year the airplanes of the Air Transport Command carried cargo, passengers, and mail a total of 857,511,531 ton-miles. Over the roughest and most difficult air route in the world, the well-known "Hump" from India to China, we carried some 250,000 tons in 1944, or a little more than twice the capacity of the much-publicized Burma Road.

Under the leadership of Lieut. General Harold L. George, the Air Transport Command has stepped many years into the future of air transportation and has taken on a job which may not develop in the field of postwar commercial air cargo for some years to come. How soon, is a challenge for the aircraft designers, manufacturers, and operators. They must prove that it can be done cheaply. Their problem is to develop combinations which will deliver by air, between the points of supply and demand, as economically, moneywise, and quickly, timewise, as competing forms of transportation. When this can be accomplished the airplane may be expected to become a commercial freighter of the skies.

Studies on the MACHINABILITY *of* CARBON *and* ALLOY STEELS

By G. P. WITTEMAN

ASSISTANT METALLURGICAL ENGINEER, BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

THIS paper deals primarily with the machinability of cold-finished bars and parts produced from this material on what are commonly known as screw machines, either single- or multiple-spindle automatics, and on the turret lathe, which is semiautomatic in operation.

Manufacturers of cold-finished products generally refer to their raw material as "hot bars," and to its source as the "hot mill." This field covers a multitude of specifications, most of which concern machinability. This presents a challenge to the staff of the hot mill, which, whether the mill be integrated or nonintegrated, must therefore necessarily be machinability-conscious in order to keep pace in such a broad and competitive field.

Modern machine tools have been skillfully engineered, especially in the application of antifriction bearings, and cutting speeds and corresponding feeds have consequently been greatly increased. Likewise, tool engineering and tool materials have advanced to the point where high efficiencies may be maintained in a complex system of tools, operated either singly or simultaneously. Furthermore, many products undergo secondary operations which generally are performed cold. These operations include crimping, bending—both across and with the grain, swaging, flanging, riveting, welding, and threading—cut, milled, or rolled. Parts which are to be heat-treated to meet a certain hardenability or definite physical requirement must be given added consideration.

Manufacture of automatic-machine products involves four fundamental factors, the machine, the tools, the coolant, and the steel being machined. The latter is affected by the steelmaking process, the rolling of the hot bar, and the subsequent cold-finishing method, turning, grinding, or cold-drawing, familiar to all. The field is further broadened through a choice between acid bessemer, acid and basic open-hearth, and electric-furnace steels of carbon, sulphurized free-cutting, and alloy compositions. With this combination the steelmaker and his metallurgical staff and the hot-mill operator must be ever-alert to all requirements if satisfactory machinability is to be attained.

FUNDAMENTALS OF STEELMAKING

A review of steelmaking and "hot-mill" practice involves a mass of detail which it is impossible to discuss fully within the scope of this paper. To summarize steelmaking, quality control is a function of a number of factors, such as (1) raw materials, (2) hot metal, (3) charging and melting practice, (4) slag control, (5) refining practice, (6) finishing and deoxidation practice, and (7) molds and pouring practice. Having obtained the proper cast metal or ingot, there follows the conversion into hot-rolled bars. Here metallurgical control is necessary in order to establish the correct relation between the heating and finishing temperatures and the cross section being rolled, and the type of mill, the finishing speed and the hot-bed facilities. Given this wide range of equipment, the metallurgical observer is confronted with the task of securing proper control for a coarse as-rolled grain size, in bars or coils. This is considered the best condition for machinability and refers only to compositions embracing the normal and high-sulphur types in low- and medium-carbon steels, applied without subsequent heat-treatment above the critical range. Higher carbon and alloy steels which require annealing or heat-treatment will be discussed later.

With our product established as hot-rolled bars and subsequently fabricated into cold-drawn bars, the question arises: "How will they machine?" This in a broad sense is "machinability," defined as that property of a material which affects the speed at which a given cut may be taken under otherwise identical conditions. In such a scope there are two means of evaluating machinability, namely, (1) short-time tests at relatively high speeds and feeds, which give tool breakdown rather than tool failure and which furnish the best comparisons in so far as tool materials are concerned, and (2) long-time tests at optimum speeds and feeds with tool failures predicated on finish and maintenance of tolerances as they pertain to the finished part. This type of test is more accurate in evaluating the material being cut, especially in connection with multiple-spindle automatic machines.

STUDIES OF MACHINABILITY OF STEELS

The diversified production of the author's company, including the manufacture of tool steels, affords almost unlimited opportunities to study machinability in practically all its phases. Furthermore, for the last 8 years research work has been going on in the development of free-cutting steels. In connection with this part of the project, Bethlehem's Lebanon plant has a modern $1^{5}/_{8}$-in., model R-6, four-spindle National Acme Gridley automatic, which is used for testing numerous compositions of steel. On this machine we initially applied a short-time test using a simple turning tool and a straight side-forming tool, running independently of each other. In tool-life evaluation, the test was started at a high speed purposely set to cause early failure. In case of forming, the speed was then progressively reduced until an optimum was reached, where failure became a function of extended time. This point was taken as the cutting speed or machinability of a given steel for the forming operation, Fig. 1.

Much data were gathered over a period of 4 years in testing a great number of compositions of free-cutting steels made under varying conditions in the Bessemer and the basic open hearth. Under present-day conditions sulphur is the most widely used element for obtaining increased machinability, for the reason that we have had more experience with it than with any other element, metallic or nonmetallic. Over a wide range of tests, results have indicated that between 0.05 to 0.35 per cent sulphur the cutting speed for turning, under the conditions of the test, was increased 1.43 sfm for each 0.01 per cent, based on 1000 min tool life.

The forming tests from 0.05 to 0.35 per cent sulphur showed an increase in cutting speed of 3.66 sfm for each 0.01 per cent, based on 100 pieces, Fig. 2. This was not a commercial

Contributed by Special Research Committees on Cutting Fluids and on Metal Cutting Data and Bibliography and presented at the meeting of the Chicago Section, Chicago, Ill., June 18–19, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

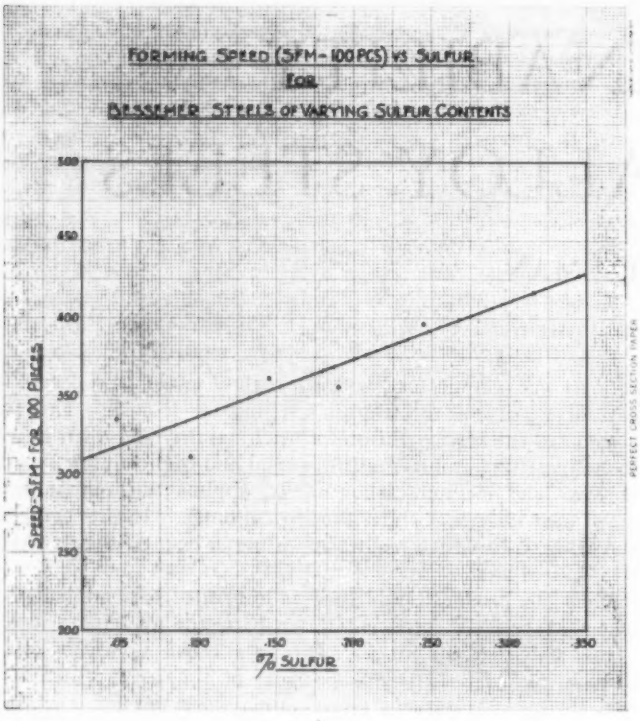


FIG. 1 SHORT-TIME TEST, SIMPLE FORMING TOOL

FIG. 3 LONG-TIME TEST, THREAD-PROTECTOR CAPS FOR SUCKER RODS

(Feed, 0.0037 in all cases.)

test for the reason that such tests, at normal speeds, would have consumed an excessive amount of material.

Elements other than sulphur have been tested in various compositions and several are under consideration for postwar development.

After reviewing past data, it was recently decided to abandon the short-time test and adopt the long-time test, whereby the product from the automatic could be used as a salable part. Accordingly, the part selected was a thread-protector cap for sucker rods shown in Fig. 3, which utilized an automatic tool setup as follows: Form, deep drill; counterbore, tap, and cutoff. To date, tests have been made on actual produc-

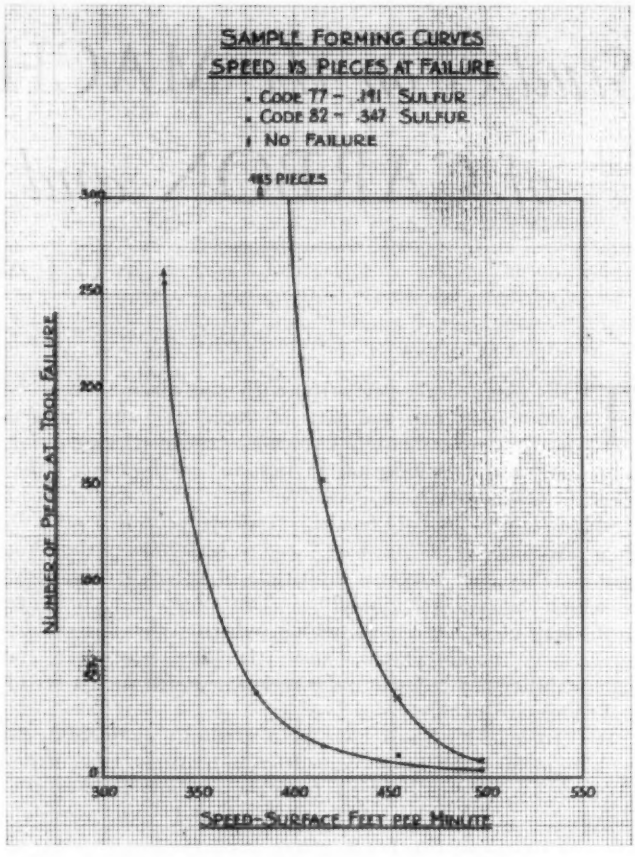

SAMPLE FORMING CURVES
SPEED VS PIECES AT FAILURE
× CODE 77 - .111 SULFUR
× CODE 82 - .347 SULFUR
↓ NO FAILURE
485 PIECES
NUMBER OF PIECES AT TOOL FAILURE
SPEED - SURFACE FEET PER MINUTE

FIG. 2 EFFECT OF SULPHUR ON FORMING; BESSEMER STEEL

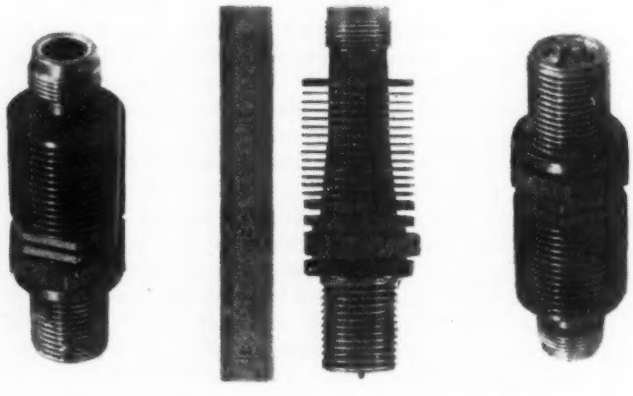
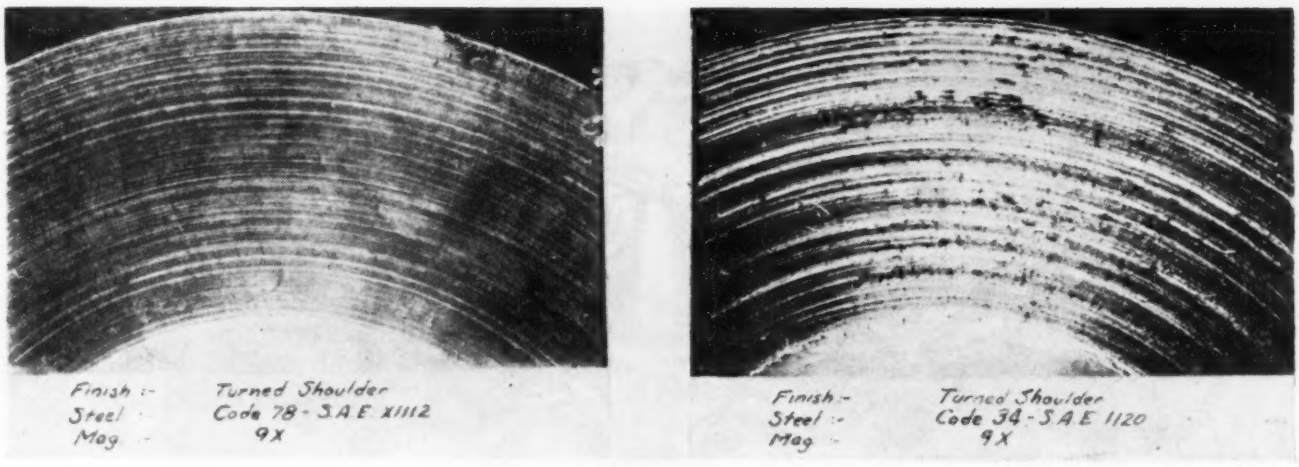


FIG. 4 QUALITY OF FINISH, AVIATION SPARK PLUG

tions using the following grades of steels: A.I.S.I. 1111, 1112, 1113, NE 8740, NE 8740 plus sulphur. The relative machinability is based upon the number of pieces per hour rather than upon cutting speed, using A.I.S.I. 1112 as 100 per cent at 75 to 80 per cent efficiency (Table 1).

MACHINABILITY ESSENTIALS FOR AUTOMATIC-MACHINE PRODUCTS

Five essentials of machinability are proposed for manufacture of automatic-machine products, namely, (1) tool materials and tool design, (2) cutting speeds plus feeds, (3) cutting fluids, (4) finish and tolerances, and (5) condition of chips. These are interdependent, for in the final analysis they govern the number of pieces per hour which an automatic machine will produce. The part will not be profitable if the machine is shut down too frequently for tool grinding, or if it is necessary for the operator to stop for cleaning out chips. This directly affects the efficiency by reducing the net pieces per hour; hence the speed, feed, or both should be altered to suit conditions.



(*a*) (*b*)

FIG. 5 MACHINE FINISHES, BESSEMER AND OPEN-HEARTH STEELS

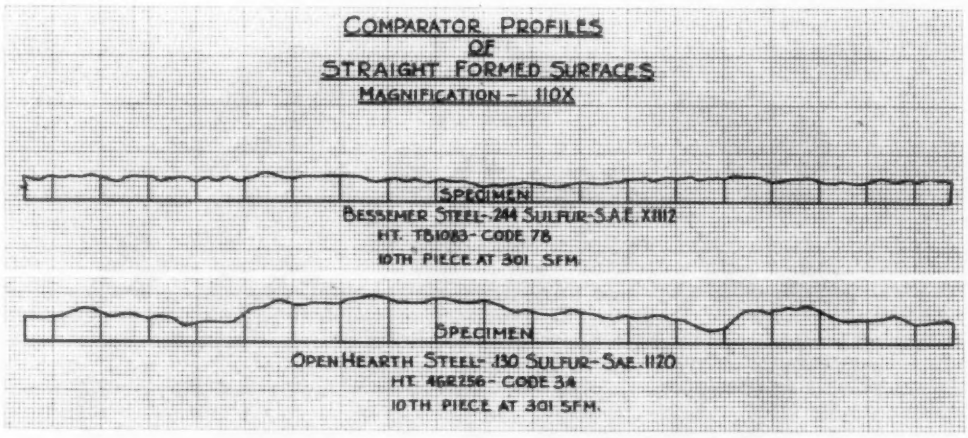


FIG. 6 COMPARATIVE PROFILES OF STRAIGHT-FORMED SURFACES, OPEN-HEARTH AND BESSEMER STEELS; ×110

TABLE 1 MACHINABILITY COMPARISONS FOR THREAD-PROTECTOR CAPS

COLD DRAWN BARS, 1½" DIA — BESSEMER AVERAGE BRINELL 187; ALLOY 223

A.I.S.I. GRADE	SFM	FEED	PCS/HR	RELATIVE MACHINABILITY
1111	135	.0052"	92	82%
1112	165	.0052"	110	100%
1113	220	.0052"	146	132%
*8740	155	.0028"	60	55%
*8740 + SUL	170	.0037"	81	73%

MACHINE EFFICIENCY 75 TO 80% AT ABOVE SPEEDS AND FEEDS
TOOLS 18-4-1 HIGH SPEED STEEL
* COARSE GRAINED STEEL

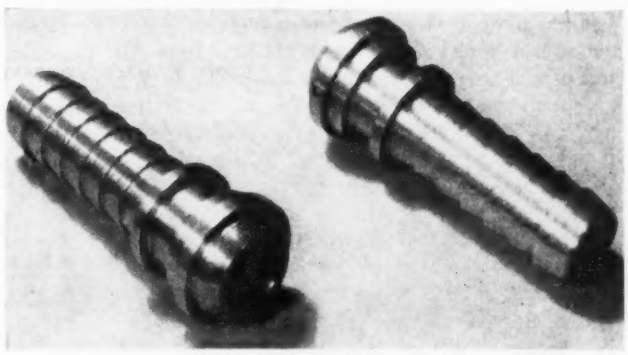


FIG. 7 HOSE COUPLING, WIDE FORM AND DEEP DRILL, BESSEMER STEEL

Finish is a mark of quality for automatic-machine products, as is clearly illustrated in Fig. 4. It varies with the type of steel being machined, speeds and feeds applied, and with the pattern of tools and the frequency at which they are resharpened. Steelmaking practice, and especially composition, often reflect machined finish. An example is given in Fig. 5, which shows a general qualitative difference of turned shoulder finishes. Fig. 5 (*a*) illustrates S.A.E. X1112 (0.244 per cent S); Fig. 5 (*b*), S.A.E. 1120 (0.130 per cent S) both at ×9 magnification. In Fig. 6 the same two pieces are shown in a profilographic study of formed surfaces at ×110 magnification. Both represent the tenth piece after initial grinding of tools, specimens being taken from test runs at 301 sfm. The comparison is of interest because better finish prevails with S.A.E. X1112, owing to the greater composition hardness and the higher sulphur content.

Cutting oils are mentioned as being important in the general scheme of machinability. Specifically, the type and volume of coolant determine the heat absorption from the work, which improves both finish and tool life. As an example, the part shown in Fig. 7, comprising an exceptionally wide form with a long drilled hole, generates considerable heat where the form

FIG. 8 MACHINED PARTS, B-1113

FIG. 9 MACHINED PARTS, SPECIAL OPEN-HEARTH STEEL

FIG. 10 MACHINED PARTS, C-1117, SHOWING DIFFERENCES OF CHIPS

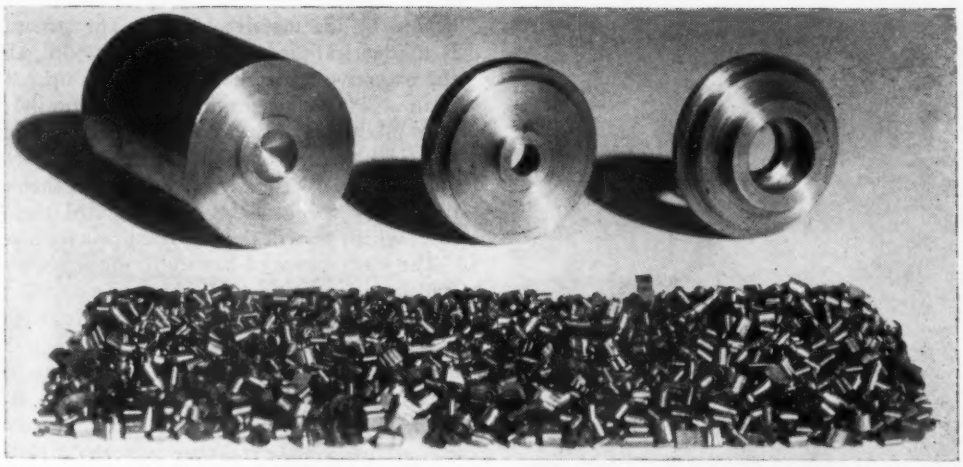


FIG. 12 LARGE ROUNDS, BROKEN CHIPS, SPECIAL BESSEMER STEEL B-1112

tools and drills are operated simultaneously. Soluble oil has served best on this type of work.

Due to the multiplicity of operations connected with automatic machines, to say nothing about the thousands of parts produced therefrom, it is obvious that the steelmaker has his share of complaints. By resorting to metallurgical investigations, endeavors are made to correct the difficulties; however, this is not always easy, for what answers in one case might otherwise be useless. Certain clues are at our disposal so let us see how they fit into a particular situation.

DETERMINING QUALITY FROM CHIPS

Chips often reveal quality characteristics in free-cutting steel, provided the tools are properly ground for a given condition. A series of exhibits of various automatic screw-machine products will be presented.

1 The parts shown in Fig. 8 were made on a multiple-spindle automatic from B-1113 with cold-drawn hardness Rockwell B-87/89. This group of chips is desirable as they are well broken up, with only a few tightly wound curls from drilling. Note the "papier maché" effect of the larger chips, conducive to good forming. As these parts involved a test on different types of steels, all tools were ground to suit conditions, and they were resharpened at the start of each test run.

2 Fig. 9 represents parts machined from an open-hearth steel made especially to simulate B-1113, with cold-drawn hardness Rockwell B-95/97. Note that the chip formations are very desirable, as they are entirely broken up, even to the absence of continuous drilling curls.

3 Fig. 10 shows two groups of chips taken from different machines operating on identical parts, made from the same type of steel (C-1117). Here the disparity of chips can be accounted for by the manner in which the tools had been ground, or by the normal wear of one tool, compared with the other at the time the chips were collected.

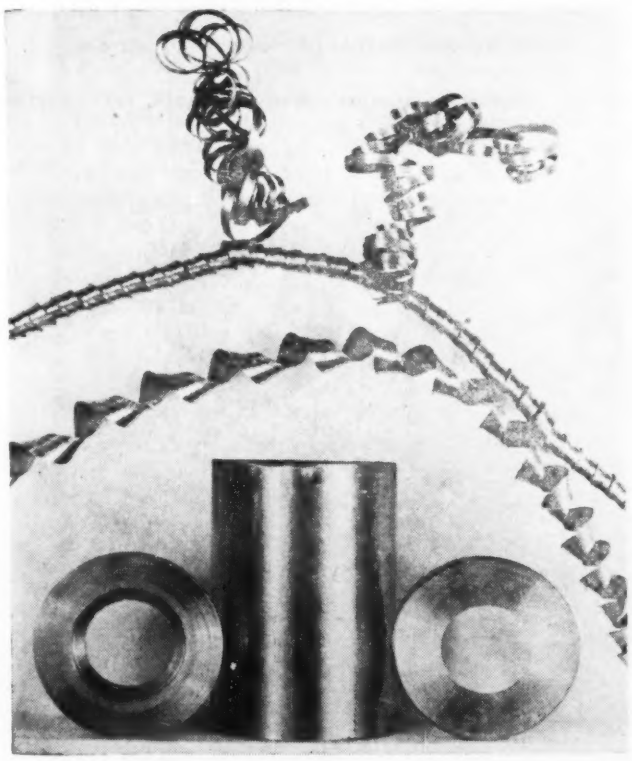


FIG. 11 STRINGY CHIPS, LARGE ROUNDS, BESSEMER STEEL B-1112

Generally speaking, long stringy chips are undesirable because they congest in and around the machines, necessitating frequent removal. Also, they accumulate at the tools to such an extent that the coolant does not function properly. Fig. 11 shows a type of chip which is frowned upon by many operators. Incidentally, the steel is B-1112, and even though classed as free-machining, it is sometimes an offender, particularly in the larger diameters. On the other hand, there are instances where continuous stringy or ribbon chips are desirable. For example, elevator tees which are planed in long lengths require a smooth finish; therefore, any breaking away of the chips will show an interruption of the cut along the surface. Also, in the manufacture of steel wool the steel is actually fibered so as to produce long continuous ribbons.

In this case we are dealing with a relatively large cross section of a $2^1/_8$-in. round. The effectiveness of cold-working is somewhat less than, say, with a 1-in. round. Actually, the per cent reduction is 5.79 for $2^1/_8$-in. round and 11.4 for 1-in. round, using $^1/_{16}$-in. draft. Here cold-working did not give desirable machinability, so the responsibility was placed with the type of steel used. The condition was overcome by a special practice at the Bessemer converter, and in Fig. 12 is shown B-1112, $2^1/_8$-in. round cold-drawn steel having short well-broken curls.

Reasons for differences in machinability are often found through use of the microscope; also, the physical properties of the steel, with special reference to the impact values, may frequently be relied upon for certain information. Moreover, certain commodities are made from materials other than cold-drawn bars; among these are forgings.

Fig. 13 represents forged-steel pipe unions and components,

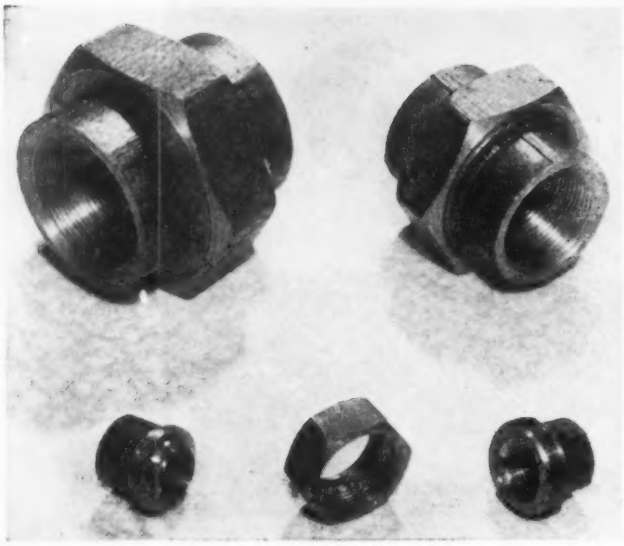


FIG. 13 FORGED-STEEL PIPE UNIONS AND COMPONENTS, BESSEMER STEEL

made on a special forging machine capable of producing 43 pieces per min, commensurate with feeding the bar stock into the dies. In such rapid production the forgings are finished above the critical temperature and accumulate in piles. These piles cool slowly from the center to the surface, hence the forgings become effectively annealed, to a degree governed by their locations in the pile. Economic considerations do not permit normalizing of free-cutting steels for this application. Acid Bessemer steel, owing to its characteristics, has always possessed good machinability in the as-forged condition, even if mass-cooled, whereas basic open-hearth steel does not machine satisfactorily unless the pieces are spread out, or even water-quenched, depending upon the size of the forgings.

MICROSCOPIC EXAMINATION OF SPECIMENS

By microscopic examination at ×100, we observe in Fig. 14 relative structures of the pipe-union forgings. The upper left illustration is a basic open-hearth forging cooled in a mass, and taken from the center of the pile. This structure indicates that the forging has been effectively annealed, as evidenced by the massive ferrite. The structure directly below is an identical piece normalized at 1750 F, air-cooled, whereby the excessive ferrite has been broken up. At the upper right is an acid Bessemer forging, experimentally cooled in ashes so as to produce massive ferrite. Again the structure below is the identical piece normalized at 1750 F air-cooled. Had both forgings been properly cooled from their forging temperature, they would have approximated the normalized structures which present the best condition for machinability.

The significance of having forgings with proper structure is evidenced by considerable threading on the parts, which is an important requisite of a good machining steel, Fig. 15. Moreover, the smaller sizes are tapped with solid taps which are backed out; thus any congestion of chips or tearing will ruin both threads and taps. The chips are of passing interest, those on the left being short tight curls from turning and boring. Those on the right are from the shaving tool in finishing the ball seat.

We continue with parts as produced on turret lathes, with special reference to steelmaking and the physical aspects of the investigation. Fig. 16 represents a worm shaft, machined

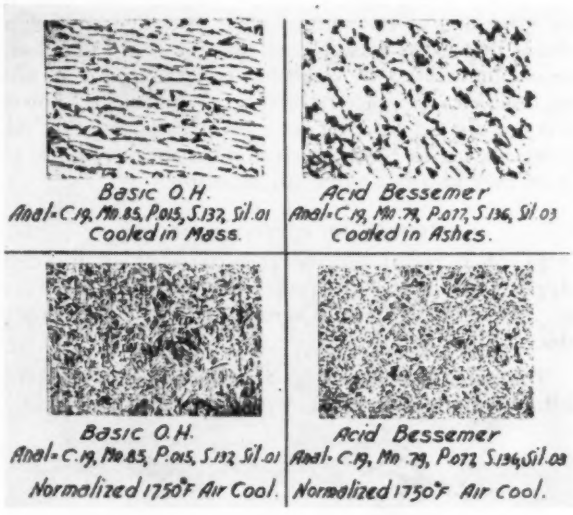


FIG. 14 STRUCTURES, FORGED PIPE-UNION PARTS, FREE-CUTTING STEELS

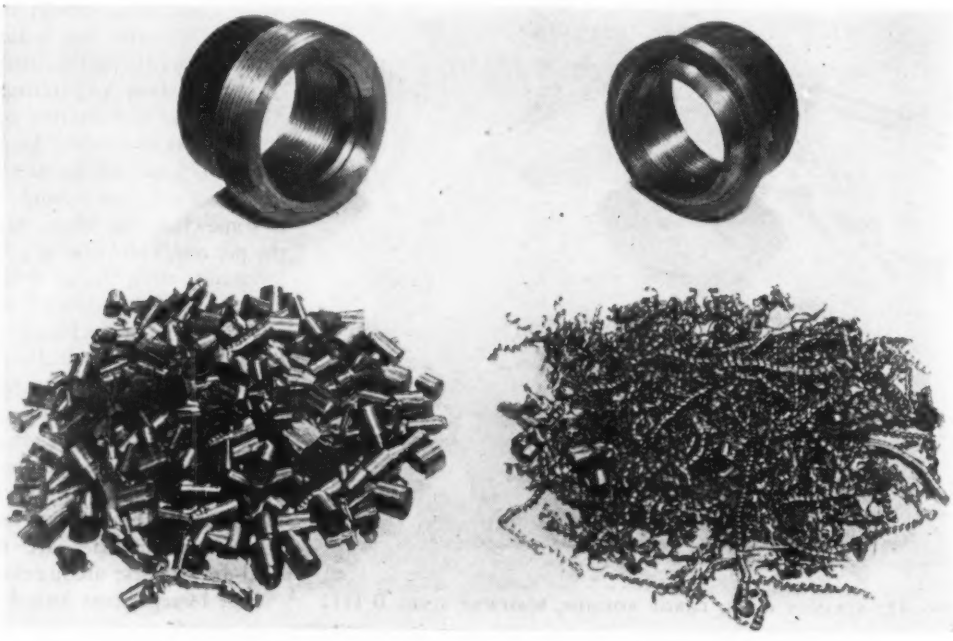


FIG. 15 FORGED PIPE-UNION COMPONENTS, SHOWING BALL SEAT AND THREADS

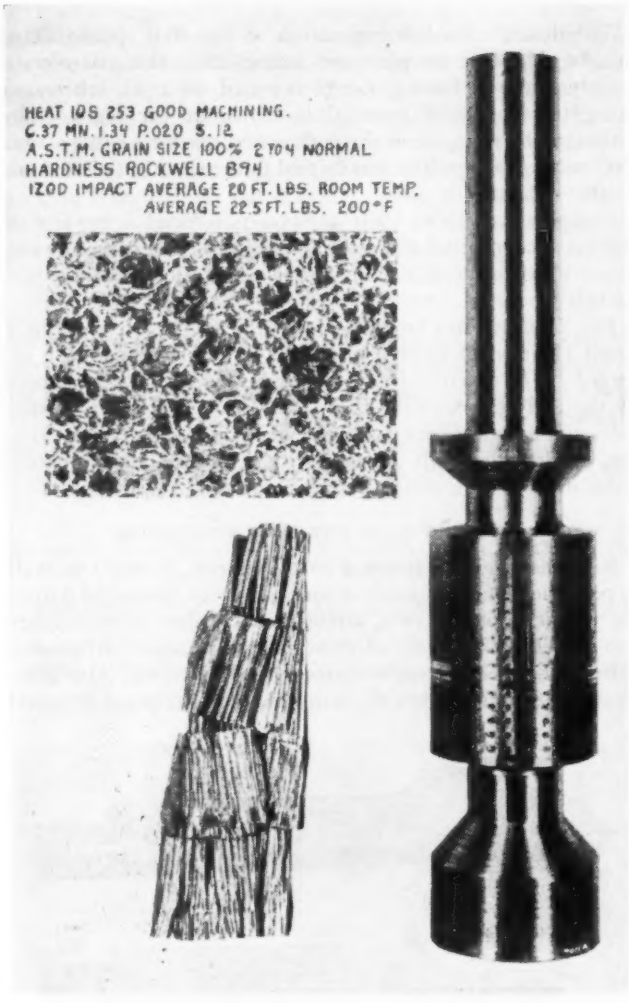

HEAT 105 253 GOOD MACHINING.
C.37 MN.1.34 P.020 S.12
A.S.T.M. GRAIN SIZE 100% 2 TO 4 NORMAL
HARDNESS ROCKWELL B94
IZOD IMPACT AVERAGE 20 FT. LBS. ROOM TEMP.
AVERAGE 22.5 FT. LBS. 200° F

FIG. 16 WORM SHAFT, C-1137, GOOD MACHINING

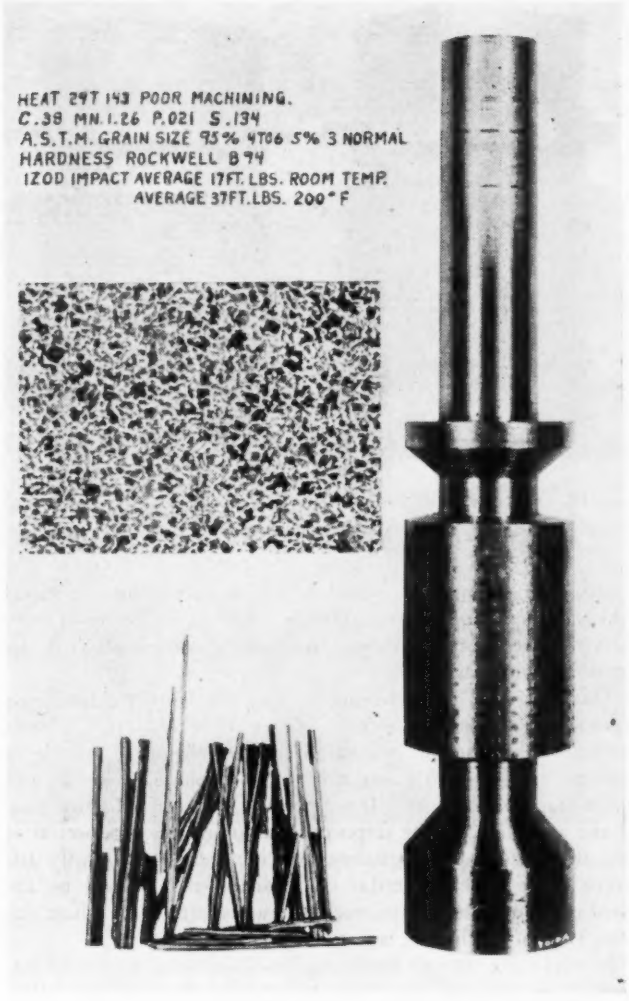

HEAT 297 143 POOR MACHINING.
C.38 MN.1.26 P.021 S.134
A.S.T.M. GRAIN SIZE 95% 4T06 5% 3 NORMAL
HARDNESS ROCKWELL B 94
IZOD IMPACT AVERAGE 17FT. LBS. ROOM TEMP.
AVERAGE 37FT. LBS. 200° F

FIG. 17 WORM SHAFT, C-1137, POOR MACHINING

with a wide form tool. Due to the composition of the steel, C-1137, and the dimensions of the form, mechanical feeding of the tool was not possible, but feeding had to be done by hand to minimize chatter. All data are shown in the illustration; however, special note should be taken that this is good machining, A.S.T.M. grain size is 2 to 4, normal, Rockwell hardness B-94, Izod impact average 20 ft-lb at room temperature, and 22.5 ft-lb at 200 F, and the chip has what we previously called a "papier maché" appearance indicative of good forming. The operator had no difficulty feeding the tool manually.

Fig. 17 shows a shaft classed as poor machining, attributable to the impracticability of manual feeding of the tool. Note that while the chips are fine, well broken, with half-to-full curls, they do not represent what we are accustomed to see in a steel having good forming properties. Let us compare data with the previous shaft. This one is 0.01 per cent higher in carbon, 0.08 lower in manganese, 0.01 higher in phosphorus, and 0.014 per cent higher in sulphur. The A.S.T.M. grain size is 95 per cent 4–6, 5 per cent 3, normal, which at the best is an average of 5 compared with an average of 3 on the previous shaft, and the Rockwell hardness is the same. Microstructures at ×100 are representative throughout for both the good and the poor shaft in the as-rolled cold-drawn condition. At ×700 the good shaft showed 50 per cent lamellar pearlite, while the poor shaft had 30 per cent. In conclusion, the average impact value of the good shaft was 20 ft-lb at room temperature and 22.5 ft-lb at 200 F. It is seen that the poor shaft gave average values of 17 ft-lb at room temperature and 37 ft-lb at 200 F, indicating a rather marked increase when the impact specimen is heated.

No explanation is offered for this method of testing, except to state that it endeavors to simulate conditions at the cutting edge of a tool, utilizing, of course, a coolant. Heating the impact specimen imparted notch toughness or greater grain cleavage to the poor-machining steel. This is reflected by the fact that the finer-grain steel was more fully deoxidized, which is revealed by the A.S.T.M. grain-size checks.

REMOVING METAL PROPERLY

Frequently considerable attention is paid to the economic aspect of machinability, in low-cost removal of metal with little or no thought being given to the effect on the integral condition of the finished product. With production paramount, heavy cuts with comparable speeds and feeds are usually employed. Should the material be poor-machining in regard to surface finish, the net results are likely to be hazardous, particularly in highly stressed parts. Likewise, the amount of metal and the means by which it is removed are vital in the quantitative effect of cold-working. When a finished product has been reduced to a light section with heavy cuts, incidental cold-working resulting from machining stresses may change the entire physical characteristics of the original material.

An excellent illustration is furnished by the airplane-engine cylinder sleeves shown in Fig. 18, in which a large volume of metal must be removed to produce the cooling fins. These fins are seen in the finish-machined cylinder, the one on the left in the illustration being in the rough-machined state. A

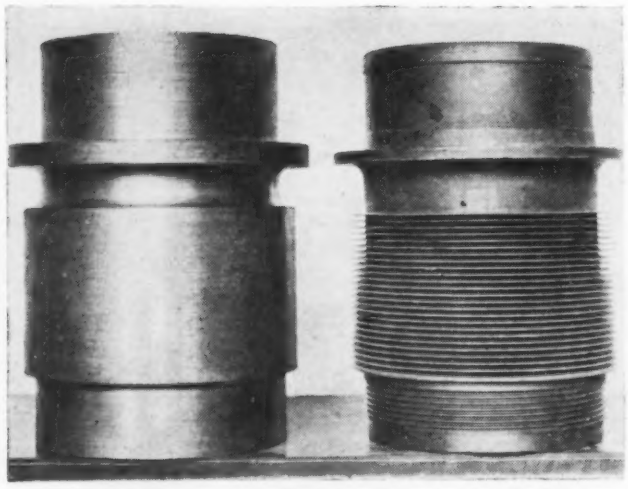


FIG. 18 AIRCRAFT-ENGINE CYLINDER SLEEVES, ROUGH-MACHINED AND FINISH-MACHINED

comparison of the two cylinders makes the amount of metal removed appear quite large, but the contrast will be even more striking if the original rough forging be compared with the finish-machined cylinder.

This is clearly brought out in Fig. 19 showing the cross sections of cylinders in three stages of manufacture. As a matter of interest, the weight of the rough-forged barrels in this case averages 651 oz, the rough-machined 376 oz, and finish-machined 104 oz. It is apparent that the machinability of the steel is a highly important factor in the production of this article. A special-quality steel is produced, basically different from steel of similar composition that would be applied to many other parts, such as crankshafts, etc., where the same type of machining is not involved.

In producing smooth finish-machined surfaces, it is most important to consider the characteristics of the material being machined and its response to the action of the cutting tool. Such smooth surfaces are essential; otherwise, shallow to deep toolmarks may act as focal points for stress concentrations, which start fatigue failures. As it is not always possible, even with the best tool practice, to obtain what is desired, grinding may be utilized if feasible.

CUTTING ACTION AT TOOL

To illustrate the cutting action at the tool, photomicrographs of A-4137 are presented in Fig. 20. The coarse-grain structure at the left represents as-rolled material, whereas a fine-grained annealed material is shown at the right. The photographs were taken through actual machine cuts so that the built-up layer which has formed in the front of the tool can clearly be seen.

Comparatively, this built-up layer is somewhat heavier in the annealed material and is the same effect as that caused by the massive ferrite encountered in the forged-steel pipe unions previously discussed.

Fig. 21 illustrates how this condition can be improved by a small addition of sulphur to A-4137, the structure being as-forged. The practical freedom from built-up layer is evidenced by the early break of the chip. However, prevailing cutting rates and depth of cuts combined with time, signify tool failure, so that the built-up layer will be present although to a lesser degree in free-cutting steels containing sulphur.

MACHINING ALLOY STEELS FOR AMMUNITION

Now that we have touched on alloy steels, it might be well to point out that thousands of tons have been fabricated during the war into bullet cores, armor-piercing shot, small-caliber gun barrels, etc. Some of these include annealed structures, either hot-rolled or supplemented by cold-drawing; also heat-treated materials within the hardness limits imposed by good

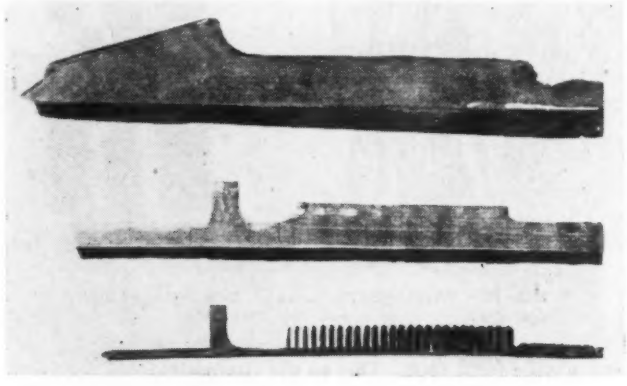


FIG. 19 CROSS SECTIONS, AIRCRAFT-ENGINE CYLINDER SLEEVES

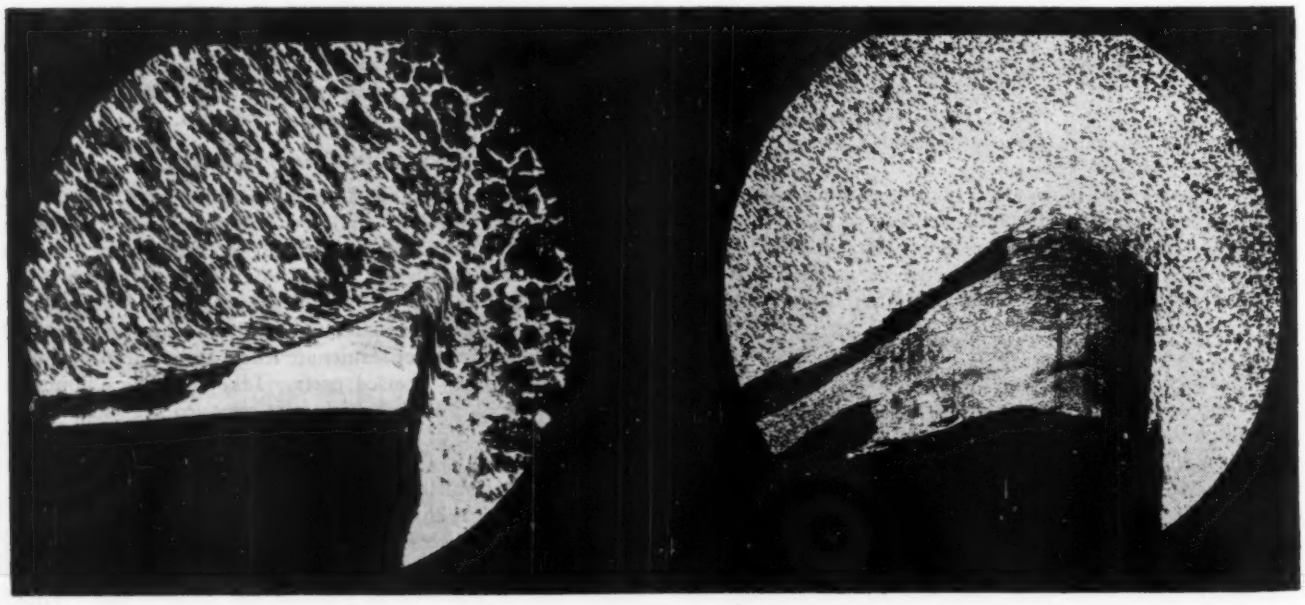


FIG. 20 PHOTOMICROGRAPHS, A-4137 COARSE- AND FINE-GRAINED STEELS

machining. Means have been devised to produce, on multiple-spindle automatics, manganese-molybdenum 0.30-caliber bullet cores in 3 sec, 0.50-caliber bullet cores in $4^1/_2$ sec; chrome-molybdenum A.P. shot, 20 mm, in 19 to 24 sec; A.P. shot 37 mm in 34 sec; while 0.50-caliber gun barrels have been drilled at a rate of $1^1/_8$ ipm with peripheral drill speed of 140 sfm, as heat-treated to Brinell 272/321. With this brief review of only a very small fraction of current machining operations, one can picture what may be expected in the future.

SUGGESTED STRUCTURES FOR MACHINABLE ALLOY STEELS

Alloy steels, with only a few exceptions for sulphur additions, are dependent upon structure and hardness combinations for machinability. This is quite complex owing to (1) a wide variety of machining operations, (2) the various structures and hardness attainable with a multude of alloy compositions.

Table 2 is an attempt to simplify the problem by suggested

TABLE 2 MACHINABILITY OF ALLOY STEELS, SUGGESTED STRUCTURES

MACHINABILITY ALLOY STEELS SUGGESTED STRUCTURES

CARBON RANGE	PROCESS	STRUCTURE	TURNING	FORMING	DRILLING	BROACHING
LOW	NORMALIZE & ANNEAL	BLOCKY FERRITE	GOOD	GOOD	GOOD	GOOD
MEDIUM	ANNEAL	SPHEROIDIZE	GOOD	POOR	FAIR	POOR
MEDIUM	ANNEAL	LAMELLAR	FAIR	GOOD	GOOD	GOOD
MEDIUM	HEAT TREATED	SORBITIC	FAIR	FAIR	FAIR	FAIR
HIGH	ANNEAL	SPHEROIDIZE	GOOD	GOOD	GOOD	FAIR
HIGH	ANNEAL	LAMELLAR	FAIR	POOR	POOR	POOR
HIGH	HEAT TREATED	SORBITIC	GOOD	FAIR	GOOD	GOOD

structures. In drawing any conclusions from the suggestions it should be noted there are three carbon ranges, low, medium, and high, which must be considered separately as they have a pronounced effect on the resultant structures. Also, there are three types of structures, lamellar, spheroidized, and sorbitic. These are obtained by numerous methods, such as heating above and slow cooling through the critical range; heating within, holding and slow cooling below the critical range; isothermal annealing; normalizing and drawing; or quenching and drawing. In some cases, the resultant structure and hardness fit ideally into a specific machining operation, and it is safe to claim that no one combination of structure and hardness will satisfy all types of machining. In this connection it should be realized that the efficiency of one machining operation must be sacrificed for the efficiency of another machining operation. Otherwise, a compromise must be accepted in order to obtain the most economical machining. Specifically, there are cases where turning, broaching, and gear-cutting are involved, and it has been found more economical to use double treatment, that is, spheroidize-anneal for turning, followed by a lamellar-anneal for broaching and gear-cutting.

Another important question is the uniformity of structure and hardness characteristics of a given furnace charge. Some types of steels have critical cooling rates to an extent that they will duplex, especially when annealed in large batches. A good example of this is 4150 which will readily spheroidize if held sufficiently long at a given temperature within the critical range. It is not possible to cool uniformly large furnace batches so that the center of the charge lags just long enough to spheroidize. Such an instance is illustrated by two 20-mm A.P. shot shown in Fig. 22, one lamellar and one spheroidized. As for machining on multiple-spindle automatics, the lamellar is preferred for the reason that the ogive, or nose, is formed and finally the entire length is skived. A spheroidized structure, unless provided for, will produce considerable chatter, with resulting early tool failure. Of passing interest is the

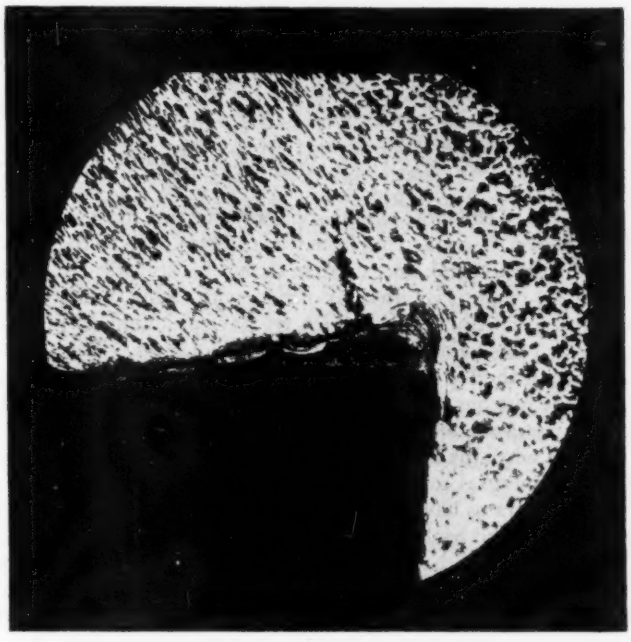


FIG. 21 PHOTOMICROGRAPH, A-4137, AS-FORGED, SULPHURIZED

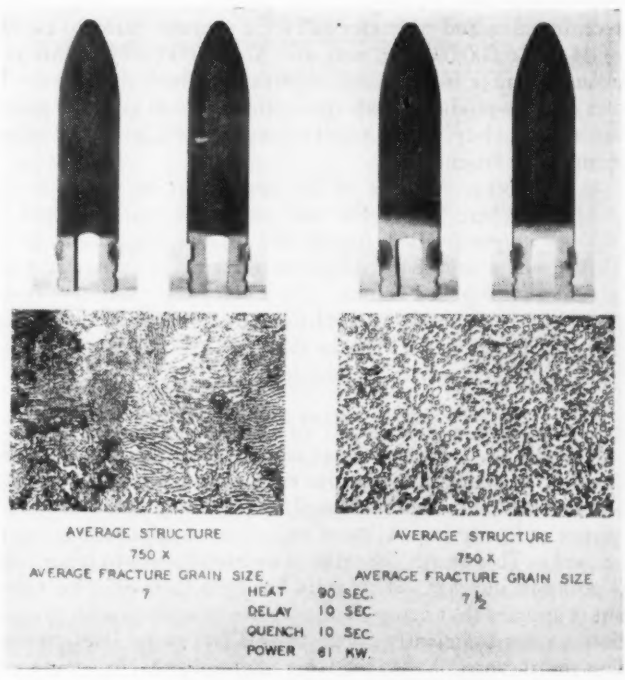


FIG. 22 20-MM A.P. SHOT, MACHINABILITY
(Good and poor structures.)

hardness pattern of the two shot as hardened by the induction method. Note that the one which is spheroidized has the shortest hardness pattern in relation to the band seat.

This is undesirable but can be controlled by adjustments in induction-hardening, a story which is important enough to require separate treatment

Increasing
PRODUCTIVE MACHINE TIME

Planning, Scheduling, and Tooling as a Means of Reducing Costs

By E. PAUL DeGARMO

ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING, UNIVERSITY OF CALIFORNIA

ONE of the most troublesome adjustments for production men, in converting from war to peace, will be the necessity to think once more in terms of cost instead of quantity. All of us, if we do a bit of honest thinking, must realize that the conditions under which we have produced during the past few years have dulled our cost consciousness. This is just another in the long list of the effects of war. But even if we have not lost our prewar cost consciousness, we probably will not be equipped adequately for postwar conditions.

To see why this is so, think for a moment about the changes that will have taken place when peace once more is with us:

1 Wage rates have increased and no thinking person can expect them to go back to prewar levels. This means that unless other factors are changed, labor costs will be higher. In any event, they will have to be watched more closely. To obtain lower labor costs labor must be used more effectively, either through the principles of motion economy or by using more labor-saving machines.

2 The technological advances attained during the war make it imperative that this nation have a larger national income than ever before and employ more people. The averages of six recent studies and estimates call for a postwar national income of $147,500,000,000 per year and 57,250,000 jobs. This is a definite change from prewar conditions. Such changes can be met only by producing vast quantities of goods at prices people can afford to buy. This again means utilizing labor and equipment most efficiently.

3 The plant capacity of the nation has been greatly expanded. Where before the war one plant was equipped to produce a given product, four or five are now equipped to do so. This means a degree of competition during the postwar years not even approached before. For a company to survive under these highly competitive conditions, its production costs must be pared to the bone. Again this implies utilizing labor and equipment as efficiently as possible.

PLANT FACILITIES MUST BE USED EFFICIENTLY

Now let us determine what relation this necessity for low costs has to productive machine time and planning, scheduling, and tooling. In order to reduce labor costs and obtain increased output at low unit cost, more and more machines are going to be used. This means the ratio of overhead costs to labor costs is going to increase. This ratio has been increasing for years, but it appears that many of us who are concerned with production are not sufficiently aware of this fact or its implications. The significance of this situation is simply that we must pay more attention to all possible methods of reducing unit overhead costs. It is no longer enough only to reduce unit labor costs. Reduction of labor costs by mechanization is often accompanied by somewhat increased overhead costs. However, overhead costs can be reduced in many ways without increasing labor costs. Also, reduction of labor costs by means of work simplification or motion economy can often bring about a simultaneous lowering of overhead costs.

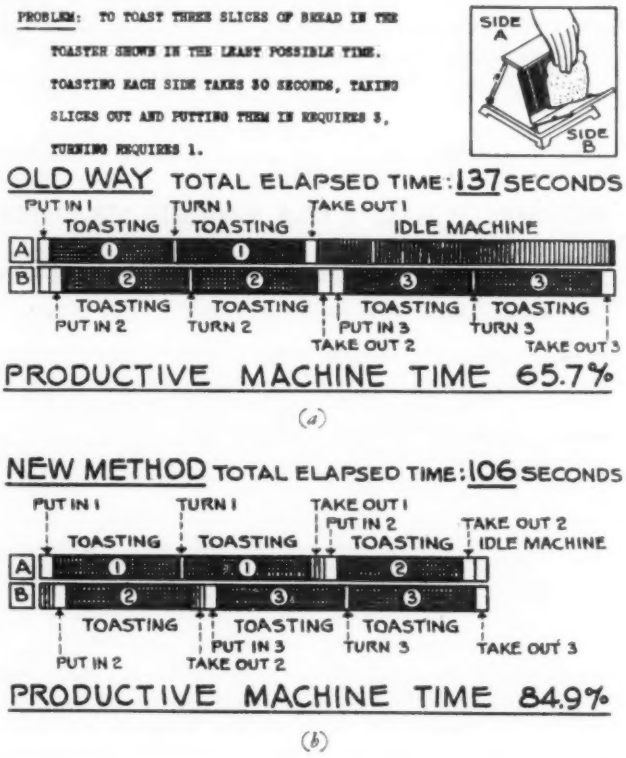


FIG. 1 ILLUSTRATING PRINCIPLE OF PRODUCTIVE MACHINE TIME

Since overhead costs are largely a function of investment in plant and equipment, reducing them means more efficient use of plant facilities. In other words, if productive machine time is increased, overhead costs are reduced. In thinking of this, any fixed production unit, be it plant or equipment, must be considered as a production machine.

To illustrate the relation of productive machine time to planning, scheduling, and tooling let us refer to Fig. 1(*a*). This is an old example but it still illustrates the point. Here is a toaster which represents an available machine. Used in the conventional manner, it is productive 65.7 per cent of the time. Now look at Fig. 1(*b*); by a simple change in operating procedure, productive time has been increased to 84.9 per cent.

This is a very simple illustration, but think for a minute about its relation to productive machine time in a manufacturing plant. What is the productive machine time of a lathe in a plant that normally operates 8 hr per day? Even if week ends and holidays are neglected, the productive machine time is only 33 per cent at best. Now suppose that due to poor or no scheduling there is no work assigned to this lathe 20 per cent of the working day. This would reduce the productive machine

Contributed by the Management Division of The American Society of Mechanical Engineers, and presented at the Bay Region Management Conference, San Francisco, Calif., March 24, 1945.

time to 26.4 per cent. Again, make an assumption that due to poor tooling or poor design of the lathe, one third of the remaining available time is consumed in setting up the work, changing feeds and speeds, or otherwise adjusting the machine. The over-all productive machine time of this lathe is thus reduced to 17.6 per cent.

Before concluding that this illustration is an absurd one, think for a moment about the machines in any particular plant. Or better yet, take an actual time check on some of the machines in that plant. Record as productive machine time only that during which the machine is actually in operation, turning out the work that it is supposed to do. Subsequently, the foregoing example will not be found too extreme.

In this example the decrease from 100 per cent productive machine time to 33 per cent is a result of planning, or rather lack of it. The decrease of 6.6 per cent was due to poor scheduling. The further decrease of 8.8 per cent was partly due to poor tooling. Thus it may be seen that planning, scheduling, and tooling all have a very real relation to productive machine time. In many cases the relative effect of each is about in the proportion indicated in this example.

REDUCING OVERHEAD COSTS

In attempting to reduce overhead costs, one should obviously pay attention first to those items that offer the greatest possible saving. If the example just cited is at all typical, it appears that the place to start is planning, i.e., planning of plant requirements, the extent of operations, and the method of operating.

Planning involves the determination of what facilities are going to be required and how they are to be used. In order to do this, definite decisions must be made regarding operation policy, what is to be produced, in what manner it is to be produced, and how many shifts the plant will operate. It requires a decision as to what is to be done and how it is to be accomplished. The result is that plant requirements are based on a planned program instead of on chance.

Obviously, if the plant in which the lathe was used were operated two shifts daily, the productive machine time would at once be doubled, assuming the other factors remained the same. This fact points out the importance of planning in connection with productive machine time. Most plants now are planning, or should be planning, their postwar operations. The determination of future plant size, the amount of equipment required, and the number of shifts to be operated are items that should be high on the planning program.

It should always be kept in mind that possession of plant and equipment carries with it the obligation to use these facilities as fully as possible, if low production costs are to result. A plant of a given size operated two shifts per day will be much more efficient, from the overhead-cost viewpoint, than one having twice the capacity but operated only one shift per day. This assumes, of course, similar equipment and operating methods. Multiple-shift operation decreases the overhead costs due to rent, depreciation, supervision, accounting, and sales effort. The problem is basically one of selecting the proper plant capacity since in such selection one should always assume that maximum possible productive time will be obtained. Whenever existing equipment is not being used around the clock, one should always suspect that plant capacity is too great. Planning, both as to plant capacity and the conduct of operations can be most helpful in obtaining very large increases in productive machine time.

Many plants will be tempted to buy government-owned property and equipment for very little in the reconversion period and thus acquire excess plant capacity. While this abnormal situation does alter the problem slightly, in most cases it will not be possible to make such acquisitions without also acquiring added overhead costs in the form of depreciation, taxes, maintenance expense, etc. Buying something that cannot be used is doubtful economy, regardless of the purchase price.

EXPERIENCE GAINED IN SCHEDULING METHODS

A large number of plants have had their first extensive experience with scheduling during this war. A goodly percentage adopted scheduling because it enabled them to obtain greater production and to meet deliveries. In other words, they have used scheduling as a means of insuring that needed parts and materials were available at the right time at the right place.

There is more than a little evidence that many companies have used their scheduling system primarily as a method of finding out where to send their expediters. Obviously, this is not the primary purpose of a scheduling system. It is commonly accepted that scheduling should assure that the correct material is at the correct place at the correct time. But scheduling can do more than is at first apparent from this statement. It is not too much to expect that scheduling should also take into account machine loading and thereby affect productive machine time. Production schedules should be made with a view to keeping work available for each machine at all times. Machine-loading charts should be used extensively. This should be a part of scheduling just as much as getting production out on time. Sending expediters to find out why machines are not busy might be a very worth-while procedure. A daily report on idle machine time would be just as useful as a daily report on failure to meet scheduled output. An adequate scheduling system is absolutely necessary in order to obtain minimum unit costs, but one should be sure that machines as well as materials are scheduled.

RELATION OF TOOLING TO PRODUCTIVE MACHINE TIME

To see the relation of tooling on productive machine time, consider the example shown in Fig. 2. This shows a machine

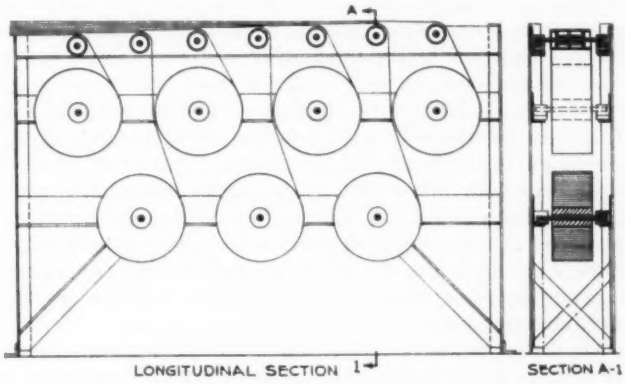


FIG. 2 SCHEMATIC DIAGRAM OF ASSEMBLING MACHINE FOR MANIFOLD FORMS

in a printing plant, used to assemble a number of printed forms into a single unit. This machine was admitted to be the most serious bottleneck of the entire plant, since most of the product had to pass through it. Company officials estimated that the machine was actually running only 35 per cent of each shift. The various units of a completed form were printed and wound into rolls about 8 in. wide and up to 18 in. diam. As many as seven of these rolls were placed in the machine illustrated in Fig. 2, at one time for assembly into the completed units. It was not practicable to have each roll the same length. As a result each roll on the assembling machine would run out at a different time. Because the forms were numbered serially, each roll had to be run out to its end.

As the operation was done, when a roll ran out the machine was stopped; the bar containing the empty core removed;

(*Continued on page 590*)

FLUID FLOW *Study of* LOCOMOTIVE FIREBOX DESIGN

By WALTER LEAF

RESEARCH TECHNICIAN, DENVER & RIO GRANDE WESTERN RAILROAD COMPANY, DENVER, COLO.

INTRODUCTION

LOCALIZED cinder cutting of locomotive fireboxes and of other types has long been a problem of major importance. By the use of the streaming double-refraction method of fluid-flow study, the problem has been approached from a new angle. The method is simple and appears to be accurate. Models are easily constructed. The general shape of the combustion arch appears to be the cause of much of the trouble. A new auxiliary arch has been tried in connection with a main arch of poor design, with only moderate success. The best solution appears to be in redesigning the main arch.

THE PROBLEM OF CINDER CUTTING

Concentrated cinder cutting has been pronounced in engines of the L-131 and L-132 classes on the author's railroad. These engines are 2-8-8-2 simple Mallets with 131,000 lb tractive effort. The grate area is 136.5 sq ft, and the firing rate is approximately 140 psf of coal per hr. The net gas area of the tubes and flues is 1884 sq in. Twenty of these engines are in service, sixteen equipped with relatively short siphons so that the arch is short and steep, one with circulator tubes, and three with long siphons.

Siphons are flattened funnels with the tube connected into the bottom of the boiler, and the body welded into the crown sheet, as shown in Figs. 1 and 2. Fig. 1 was taken from the fire door which is at the rear of the firebox, looking forward. Fig. 2 shows the combustion chamber looking toward the rear. There are two siphons in the firebox, and the arch is supported by the siphons and side sheets. Naturally, the size of the main arch is controlled by the shape of the siphon.

In another arrangement, circulator tubes are used to support the arch. These tubes, usually seven in number and about 5 in. diam, are welded into the side sheets and extend in an upward sloping fashion across the firebox to a central Y which is welded into the crown sheet.

The Gaines wall is a bridge wall at the front end of the grate section, to prevent coal going directly into the combustion chamber. Sometimes holes are left in this wall as shown in Fig. 1, to try to keep the bottom flues open by a direct draft. However, these holes soon plug up with cinders and ash and are of doubtful value.

The grates of these engines are about 110 × 180 in. The combustion chamber, from the Gaines wall to the back flue sheet, is 116 in. long. The short arches are 90 in. long and clear the crown sheet about 15 in. at the back end. Three engines are equipped with arches 130 in. long with 24-in. clearance, and one with an arch 140 in. long with 20-in. clearance.

In the sixteen engines equipped with short siphons, crown-bolt heads are severely eroded in the area starting a little way ahead of the back end of the arch, and extending into the combustion chamber. The upper four or five rows of siphon staybolt heads are also badly cut. The lower ones are not damaged. Half-moons of welding rod are tacked on for protection in this area with good results, but are expensive.

The major difficulty is with the top third of the flues. They are grooved near the superheater-tube return bends so much that they have to be renewed at about 65,000 miles.

Flues in the lower third plug solid with cinders after the first few trips out. This of course cuts down the steaming capacity.

INVESTIGATING THE CINDER-CUTTING PROBLEM

The first approach to the problem consisted in collection and screen analysis of cinder samples from various classes of engines. An attempt was made to collect a sample direct from the stack during operation, using a 1-in. pipe with an elbow, and a centrifugal separator. The moisture from the exhaust steam made a paste of this sample so it was of doubtful value. Cinders collecting on the running boards, etc., were taken from engines after long uphill movements and after long drifting movements. These samples were graded on a set of screens, burned

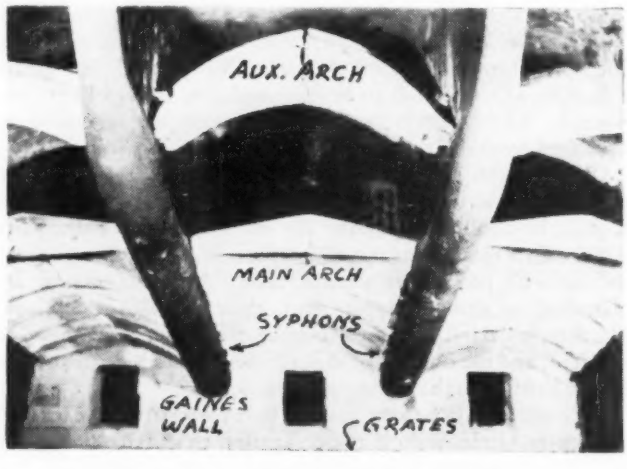


FIG. 1 INTERIOR OF FIREBOX OF LOCOMOTIVE 3613, LOOKING FORWARD FROM THE FIRE DOOR, AND SHOWING NEW ARCH DESIGN

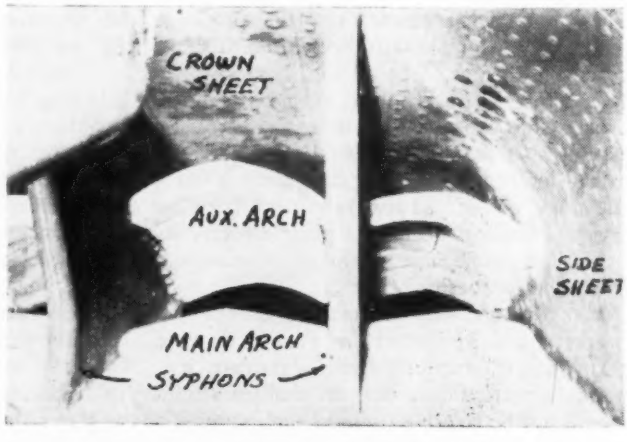


FIG. 2 INTERIOR OF FIREBOX OF LOCOMOTIVE 3613, LOOKING BACKWARD FROM COMBUSTION CHAMBER

Contributed by the Power Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

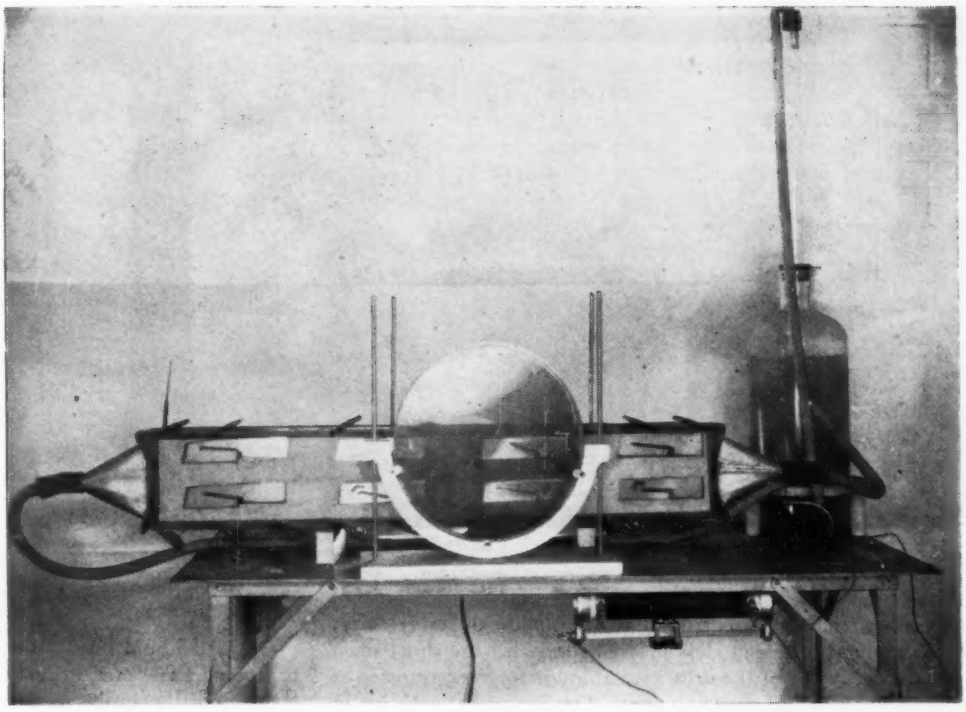


FIG. 3 SHOWING GENERAL VIEW OF APPARATUS

(The two left-hand models are of L-105 class engines, top with circulator tubes, bottom with siphons. Top right-hand model is of L-131 class engine with long flat arch. Top model behind polarizing plate is of L-131 class engine with short, steep arch, causing trouble. Bottom model behind plate shows long, flat arch on circulator tubes. Other models have auxiliary arches for study.)

in oxygen, and ash analyses tabulated. The only thing learned from this approach was that the samples consisted of partly burned coal. Material which would pass through 8 mesh and remain on 48 mesh showed a maximum of 62 per cent of the combustible to have been burned, based on the ash analysis and the ash content of coal samples. Screen samples through 100 mesh on 200 mesh varied from 60 to 95 per cent burned. Total samples showed only 57 per cent of the combustible matter to have been consumed, since the major portion of the samples was retained on the 8-mesh screen.

The next approach was with the streaming double-refraction method of fluid-flow study. This process was developed in the chemical-engineering department at the Massachusetts Institute of Technology by D. R. Dewey, 2nd, under the direction of Dr. E. A. Hauser about 4 years ago. A description of the method and some details of the technique used will be found in an Appendix to this paper.

Fig. 3 shows the apparatus. The models are outlined with strips of gasket rubber within the glass-sided channel. They represent longitudinal sections through the center of the firebox and combustion chamber. Brass strips with the proper number and size of holes represent the grate and flue sheet. A small centrifugal pump raises the suspension into the upright tube in which a connection to the model channel is teed. The flow rate to the models is controlled by a screw clamp on the rubber hose leading to the channel. The models are so arranged that the suspension is divided into two portions as it enters the channel, and the portion which flows through the upper left-hand model flows through all the upper row of models; likewise for the lower row.

The channel is $^5/_8$ in. between glasses, and the suspension is about $1^1/_2$ per cent by weight. No serious effort was made to regulate the flow rate exactly, since the general flow pattern does not change over a wide range of rate.

A simple channel which could be taken apart, the models rebuilt and put back on the line in a few minutes, was used for most of this work. The apparatus shown in Fig. 3 was assembled as a permanent display and demonstration.

FIREBOX MODEL SHOWS CAUSE OF TROUBLE

A model of the firebox having the worst condition showed very clearly why cutting occurred. The arch was so short and steep that the main stream of gas flowed along the crown sheet, and against the upper portion of the flue sheet. The lower half of the combustion chamber experienced a backward flow. Naturally, the upper tubes were cut and the bottom ones plugged. Models with longer flatter arches showed forward movement of gas over the arch and through the combustion chamber.

In order to change the arch shape to a desirable one it would be necessary to install new siphons, an expensive process, so various expedients were tried to see what effect they would have on the flow pattern. Extending the arch on downward to the bottom of the flue sheet did no good. Various obstructions at different locations were also ineffective. The only device that gave a satisfactory flow was a curved arch just above the regular arch, so designed that it directs part of the flow downward into the bottom of the combustion chamber. This auxiliary arch is shown in Figs. 1 and 2.

This shape of arch was tested on Engine 3613 for 6 months. During the first month the bottom flues were kept open, showing that the flow was well distributed at the back flue sheet. Thereafter, some trouble was experienced in maintaining the deflecting arch, portions of it dropping out occasionally. Naturally, if the arch was not kept in place the flow reverted toward the original form, and bottom flues became plugged. Also, considerable slag formed on top of this arch, further upsetting gas flow.

At the end of the six-month test, corrugations appeared in the crown sheet, so the test was discontinued. The deflecting arch was only 10 in. from the crown sheet at its closest point, and slag formation brought hot refractory even closer. Previous experience showed that 20 in. is about the minimum clearance between arch and crown sheet to prevent corrugations. The corrugations were about $^1/_{32}$ in. when discovered, and immediately above the deflector arch at its closest point to the crown sheet.

CUTTING DONE BY COAL PARTICLES

Cinder cutting is really coal cutting. The enormous coal-charging rates experienced in steam locomotives make it impossible to keep coal particles out of suspension in the gas flowing through the firebox. The cutting or abrasion action of a particle is probably roughly proportional to its kinetic

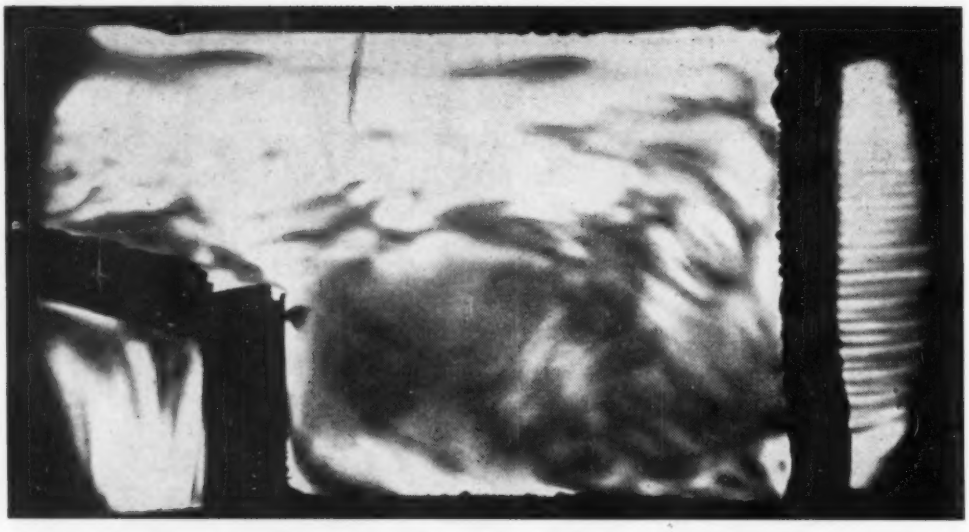


FIG. 4 COMBUSTION CHAMBER OF MODEL OF ENGINE WITH SHORT STEEP ARCH

(The vertical black line at right is the modeled flue sheet. Note that the "streamers" go downward at about 45 deg as the tube sheet is approached.)

energy, hardness, sharpness, etc. The kinetic energy of a moving particle is proportional to the square of its velocity. Flow studies of these models showed that with the short steep arch, roughly $^1/_3$ of the area available for forward transfer of the combustion gases was so used. Consequently, velocity in this area was three times as high as it would have been if the entire space was used for uniform forward transfer of the gas, and kinetic energy of the flying particles was roughly nine times what it should have been, with consequent high abrasive power.

It seems logical then to design a firebox, arches, etc., so that flow over the arch through the combustion chamber and to the flues is distributed in a uniform fashion from top to bottom and side to side. In this way, velocities of floated particles are kept at a minimum. A long fairly flat arch with lowest possible Gaines wall, with the rear end of the arch at least 24 in. from the crown sheet, seems to be the best design.

A further aid, of course, is to keep the particles out of suspension. Such devices as front-end stokers, patented grates, ash-pan designs, and uniform fire beds, all probably have some merit in this respect. Adequate air for complete combustion seems impossible at the higher firing rates; or possibly it is merely that there is not sufficient time for travel of the particle from grate to flue sheet.

Engines of the L-131 and L-132 class having long flat arches, suspended either on siphons or on circulator tubes, do not show localized cutting, and the bottom flues stay open.

Appendix

Gas and liquid both follow the same laws of fluid flow, so that with a few precautions, water flow through a small model is dynamically similar to gas flow through the prototype. The Dewey and Hauser process uses a water suspension of a specially graded bentonite clay. The particles are colloidal in size, flat plates, and double-refractive.

This last term merely means that a ray of plane or circularly polarized light passing through the particle is split into two rays, vibrating in each crystal axis of the particle. The longitudinal speed of these two rays is different, so that they emerge from the particle somewhat out of phase. The phase difference depends on the thickness of the particle or the number of similarly oriented particles traversed, the wave length of the light under consideration, and the difference in speed of the two rays through the particle, termed "refractive power." Thus if the correct amount of double refraction is placed in the path of the polarized-light beam, a particular wave length of light will come through 180 deg out of phase, and be neutralized so that it is lost entirely. As the amount of double refraction is varied, different wave lengths, or colors, of light are lost, and the remaining light beam changes color.

Since the bentonite-clay particles are flat plates, they are given preferred orientation to a greater or lesser degree by shear in the liquid; that is, if one filament of liquid is flowing at a slightly different rate than the adjacent one, the particles are blown around into a preferred orientation. The net amount

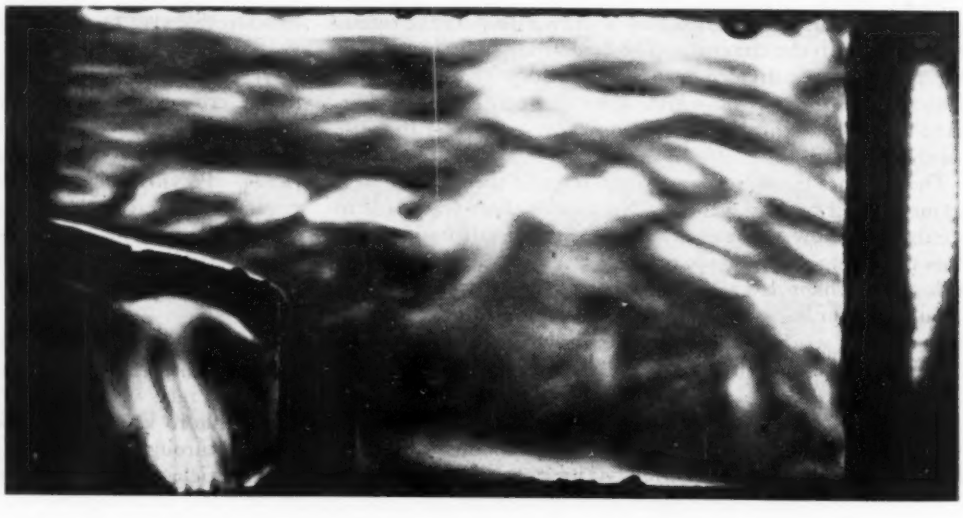


FIG. 5 COMBUSTION CHAMBER OF MODEL OF ENGINE WITH LONG FLAT ARCH

(The "streamers" approach the flue sheet at more nearly the horizontal plane than in Fig. 4. There is no significance to the difference in shading in the upper portions of Figs. 4 and 5.)

of double refraction created in the clay suspension of course depends on the number of particles in the thickness through which the light travels, the double refractive power of each particle, and the degree of orientation. Hence the color of transmitted light depends on the amount of liquid shear at any point.

During the two years that the author has been using this method of fluid-flow analysis a number of problems connected with it have been solved.

PREPARATION OF SUSPENSION

The fluid suspension must satisfy the following requirements:

1 It should not be corrosive to or otherwise affect the materials from which the model is made. Since the models may be of celluloid or other plastics, organic liquids as a class are ruled out. Water is the best liquid. This limits model metals to copper, brass, stainless steel, etc., which is not a serious limitation.

2 The suspended material must disperse to colloidal or near colloidal proportions, so that no sedimentation takes place within the system. Small particles of practically no mass are easily oriented by liquid shear.

3 The particles must be geometrically anisotropic, that is, they must be needles or flat plates, the more so the better, so that they are oriented by liquid shear.

4 The particles must be double-refractive, or optically anisotropic, if polarized light is used, whereby an interference color pattern is developed in the liquid. Fine aluminum powder can be used in certain types of investigation, and the flow pattern observed in reflected light. A wetting agent such as aerosol aids in dispersion. The aluminum powder cannot be ground to colloidal size and is thus subject to sedimentation. Its advantage lies in the fact that crossflow in a three-dimensional model may be studied by oblique illumination of successive planes across the model.

Bentonite clay of the proper type satisfies the requirements, but is tedious to prepare. The only satisfactory source of supply so far developed is a California bentonite.[1] The raw material can be obtained at a cost of only a few dollars per 100 lb.

About 2 per cent clay is allowed to soak in distilled water in pyrex bottles, or other inert container, with occasional stirring, for a week or so. Fine-grinding of the clay helps speed up the process only if vigorous and continuous agitation can be provided. Otherwise, on swelling, the finely ground clay merely makes a sticky mass which is not easily penetrated by the water. After all of the gelatinous mass has been dispersed the suspension is allowed to settle quietly for several weeks. About 0.01 per cent tetra sodium pyrophosphate aids in obtaining a stable dispersion. If a supercentrifuge is available, a good grading can be obtained rapidly, the grit and larger particles being thrown out. If more than 2 per cent clay is handled, the resulting suspension will be so viscous that sedimentation is too slow or impossible.

Depending on the degree of purity of the raw material, which is quite variable, the final suspension will have from 0.5 to 1.5 per cent solids. This concentration may be too thick or too thin, depending on the model. If the thickness of liquid viewed in the model is $^1/_2$ in. to several inches, around 1 to 1.5 per cent suspension is satisfactory. For thicker models it may be advisable to dilute the suspension to 0.5 per cent or it may not be, depending on the final clarity of the suspension. The general light-transmission qualities of the entire setup govern this point.

Recently, a new material[2] has been developed which promises decided advantage. It is so new that no name has been given it yet, but Dr. P. G. Bird, director of research, can channel orders to the proper place if synthetic bentonite is specified. This material is a white-flaked powder that disperses readily in water, and a suspension can be made up in a matter of hours. So far the author has not developed data on the concentration to use, but any investigator can readily do so. The double-refractive power of this material does not seem to be quite as good as bentonite, but is probably adequate. Its ease of preparation recommends it.

After a good dispersion is obtained it can be concentrated by evaporation, or diluted with distilled water. The only precaution necessary is to keep soluble material out of it. Thus some slight advantage can be gained by the use of pyrex glassware, since ordinary glass yields a small amount of soluble material which may coagulate the dispersion in time.

Large quantities of the suspension can be made up in advance and kept in stoppered bottles. With reasonable precautions, a suspension can be used through the models for months. Its only deterioration is caused by entrance of dissolved solids, or loss by evaporation.

APPLICATION OF POLARIZED LIGHT—DETAILS OF THE MODEL

For double-refractive studies, circularly polarized light, as in photoelasticity, is used. This is obtained by the use of two polaroid disks and two quarter-wave plates which can be obtained through scientific supply houses. These are made in sizes up to 12 in. diam and are not very expensive. The polarizing axes are determined by observing the maximum cutout of glare from a horizontal surface, with illumination above and beyond the surface. The polarizing axis is vertical, at maximum extinction. Both plates are so marked, and mounted with the axes crossed, giving maximum extinction of transmitted light. A quarter-wave plate is now placed between the polarizers and rotated until maximum extinction again occurs. The plate is marked with reference to the polarizing axis of either polarizer, it makes no difference which. Both quarter-wave plates being so marked, they are mounted between the polarizers, one plate being adjacent to a polarizer, with the axis of each plate set 45 deg away from the axis of its corresponding polarizer. Now if very little light comes through the entire setup, we have the dark field of circularly polarized light, and it remains dark regardless of the orientation of one pair with respect to the other. However, the quarter-wave plates may have been so set that the light field is obtained, in which case light is transmitted freely regardless of relative orientation of the two pairs of plates. To convert from the light field to the dark field or vice versa, merely rotate one quarter-wave plate 90 deg, thus in effect going 45 deg in the opposite direction from the first trial. But keep in mind that one pair, consisting of polarizer and quarter-wave plate, should always be kept with the respective axes very close to 45 deg apart. The relative orientation of the two pairs makes very little difference.

The light field has the advantage of greater light transmission, but brilliance of color is lost. The dark field gives good color, but poor light transmission. If both features are desired the light field can be used, and a large sheet of thin cellophane put between the pair, and rotated to give the desired effect. This is of advantage in photographing. Not all cellophane is optically active. A sheet of the ordinary wrapping variety can be tried between the polarizers. If no color is obtained, different sheets should be tried until a satisfactory one is found. For visual observation, the dark field and a 25 or 50-watt lamp are satisfactory.

The final setup then consists of a light source, with the light passing first through a polarizer, a quarter-wave plate, the model, a quarter-wave plate, a polarizer, and then to the eye of the observer, or to the camera. For photographing, a set of large condensing lenses to give a parallel light beam through the model is desirable but not indispensable. A No. 2 photoflood lamp will give sufficient light if a good camera is used.

[1] Mined by Baroid Sales Division, National Lead Company, Los Angeles, Calif.

[2] National Aluminate Corporation, Chicago, Ill.

The model is of course the item that requires the most ingenuity. The investigation merely shows the flow pattern of water going through the model. In order to convert from model flow to prototype flow, the model must be accurate in all the details that influence the flow pattern. This means that the model can represent a simple longitudinal section of the prototype, or it may have to be an elaborate three-dimensional model, complete in all details. Only judgment tempered by experience can decide the point.

For two-dimensional flow around the outside of an object, an open-topped channel with an adequate distribution system at the entrance end will suffice. The channel must be deep enough so that "crowding" does not take place around the model. For two-dimensional flow through a model, such a channel can also be used if the model can be made so that it can be put in or lifted out of the channel in relatively few pieces, the proper dams built to direct the flow through the model, etc.

For three-dimensional models, celluloid is an excellent material. It can be obtained in sheets 20 × 50 in., in thicknesses ranging from 0.02 to 0.25 in., at a nominal cost and high priority. It can be cut with shears or a saw, drilled, milled, or turned in a lathe. It can be glued together merely by wiping the joint with amyl acetate on a small brush, and letting dry a short time. Such a joint is firm, but can be split apart if mistakes are made. It can be built up to any desired thickness by piling sheet on sheet, touching the joint with amyl acetate. It can be formed to any curved shape by heating to 125 C in an oil bath and allowing it to fall into a form, such as rolled sheet metal. On cooling, it retains its new shape permanently. Naturally if the surface of the form is rough, the smooth finish of the curved piece will be lost.

If the finished model does not have parallel flat sides to look through, the situation can be remedied by immersing the entire unit in an aquarium full of water. Or if it is too large, watertight extensions can be affixed, having parallel sides, and the space between model and extension filled with water. Model building naturally is a diversified science, calling upon many techniques; and for fluid flow this is especially true.

CONVERTING FROM MODEL TO PROTOTYPE

Reynolds' law of fluid flow states that where gravitational or mass forces predominate, the flow of one fluid through a model is dynamically similar to the flow of another fluid through the prototype if the product of density of fluid, any linear dimension, and velocity at any point is roughly equal in both objects. This product is called Reynolds number. If viscosity of the fluid has any influence on the flow, then the Reynolds numbers must be divided by the viscosities of the two fluids to satisfy similarity of flow, the two resulting numbers being equal. Thus the point at which laminar flow breaks into turbulent flow can be determined fairly accurately, for it can be seen in the model, and calculated for the prototype.

Since water is not compressible, great accuracy is not possible when this method is used to determine gas flow in which great changes of volume take place. In the case of the firebox investigation, the gas passing through the grate and firebed is subject to an expansion of roughly 10 times, yet the models, simple as they were, showed all points at which trouble was experienced in actual practice. These points of trouble, however, were somewhat remote from the grate area. Where gas expansion takes place in the prototype, the model can be run at different rates, and it is believed that accurate predictions may be made.

For investigation of the velocity gradient across an area experiencing nonuniform laminar flow, a compensator as used in photoelasticity is of value. Compensators are really simple things but too elaborate to be treated here. Frocht's treatise on photoelasticity describes them thoroughly, and it would be well for any operator to read at least parts of that book to become more familiar with polarized light and double refraction in general.[3]

The use of the streaming double-refraction method of fluid-flow analysis draws upon techniques from chemistry, physics, mechanics, hydraulics, and Rube Goldberg. None of these is very difficult or complicated, and neither is the resulting process, if taken a step at a time.

Increasing Productive Machine Time

(*Continued from page 585*)

the core removed from the bar; the bar inserted into the core on which the new roll was wound; the roll lifted by hand, and the end of the bar away from the worker inserted into its socket on the far side of the machine; the near end of the bar inserted into its socket; and the end of the new roll cemented to the tail end of the previous roll. Only one bar was provided for each roll, and due to the poor design of the machine the rolls were so close together that the workman had to find and insert the far end of the bar into its socket entirely by touch. While all of this was being accomplished, four other people who attended the machine were standing idle. When the machine was running it ran at high speed, but it ran only a few minutes before another roll ran out. The 35 per cent productive machine time per operating shift resulted.

Again, while this may be a somewhat extreme example, it serves to emphasize the fact that although a machine may operate at a high speed when it is running, if it is standing still for a considerable portion of the time in order for the operator to get work set up or removed, its over-all productive time is low. Time required to service a machine, that is, to set up and remove work, is not productive. This means that careful attention should be given to the possible use of multiple-station fixtures, quick-acting clamps, proper loading and unloading heights, centralized controls, mechanical aids, use of the proper subassembly sizes, duplication of essential aids so setups can be prepared while others are being machined or produced. In other words, ample attention should be given to all subsidiary operations which must be done in order for a machine to operate.

It is perhaps fortunate that so many plants, during the war, have learned of the great increases in production that can be achieved through proper tooling. Unfortunately, there has not been a great amount of emphasis upon the economics of tooling. All production men should start now to learn about the economics of tooling; how to determine what amount of investment in tooling is justified for a given condition. It must be realized that tooling in peacetime is mainly for one purpose, namely, to lower costs.

In designing or selecting new equipment considerable attention should be given to the facility with which the loading, unloading, and control operations can be accomplished. These are done while the machine is idle and thus should be accomplished in a minimum of time. The amount of attention that has been given to this problem in the design of most manufacturing equipment, and particularly in machine tools, is entirely too little.

CONCLUSION

From these examples which have been given it is apparent that planning, scheduling, and tooling are very closely related to productive machine time. They are methods through which the production man may receive real aid in solving one of the most troublesome and important problems which will be put before him during reconversion and the days that follow, that of obtaining low production costs.

[3] "Photoelasticity," by M. M. Frocht, John Wiley & Sons, Inc., New York, N. Y., 1941.

NEW SHELLS FOR OLD—REPAIR UNIT AT WORK IN FIRST MOBILE REPAIR CENTER

(Shells which arrive tarnished at the mobile repair center are reconditioned and made ready for use. This view was taken in the first ammunition repair center in Kent, southern England.)

ENGINEERS *Into* BATTLE

By LIEUT. COL. T. A. LOWE

MODERN war is simply an expression of the industrial age in which we live, and therefore is largely a contest between engineers. The link between user and producer—the engineer in the field and the engineer in charge of manufacture and design—must be strong and complete.

The formation on October 1, 1942, of a new Corps in Britain with the title, "The Royal Electrical and Mechanical Engineers," soon brought about this link. Machine war on an ever-increasing scale required a vast engineering organization to keep the vehicles, weapons, and instruments in a state of maximum efficiency. Hitherto these functions had been carried out by the engineering staff of the Royal Army Ordnance Corps, which was responsible for all warlike stores, vehicles, and clothing. But, in addition, certain mechanical and electrical engineering maintenance was carried out by the Royal Engineers and the Royal Army Service Corps, and (as a result) there was often triplication of material, and technical manpower.

DUTIES PERFORMED BY NEW CORPS

Functions of the new Corps were therefore laid down as follows:

(*a*) Inspection and maintenance of tanks, wheeled vehicles, all artillery (including field, antiaircraft, and coast defense), small arms and machine guns, radiolocation, fire control, and all other instruments, tunneling equipment, pumping sets, and the installation of coast-artillery machinery.

(*b*) Repair of all the foregoing equipment consequent upon ordinary wear and tear, or battle casualties.

(*c*) Investigation into defects of design and recommendations for improvement.

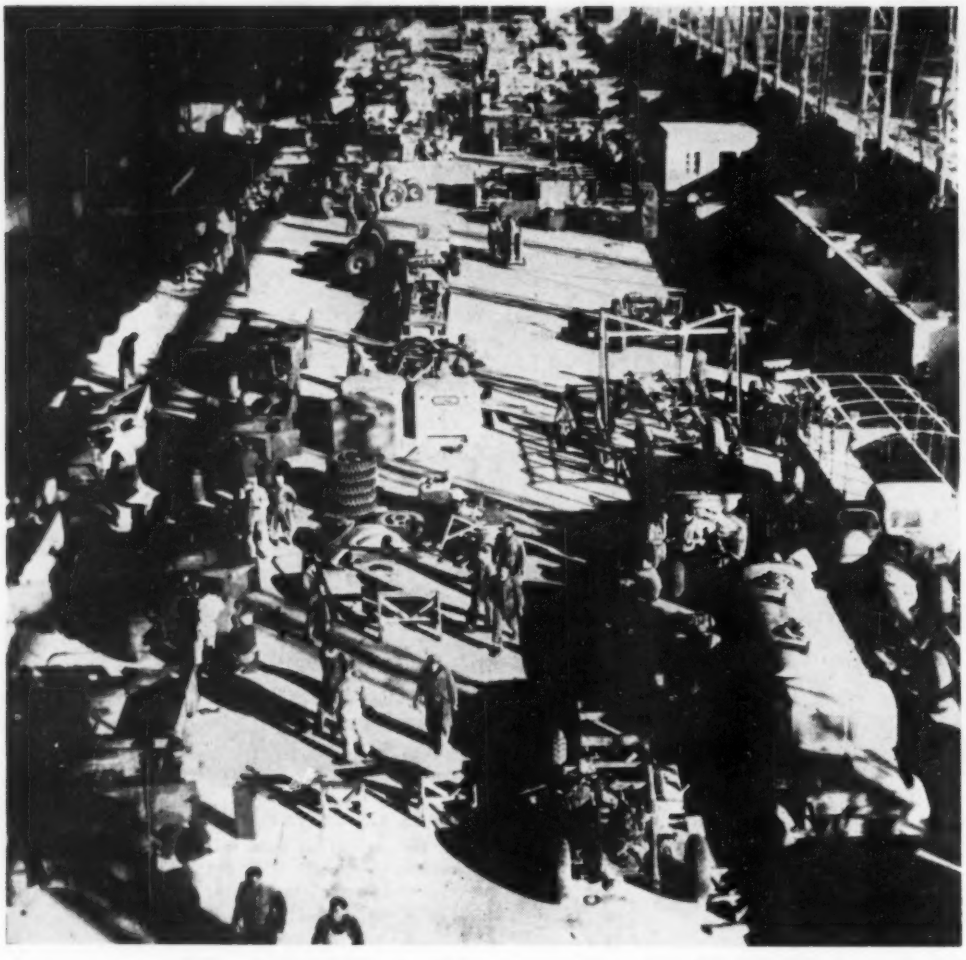
(*d*) Advice on prototype design from a maintenance angle.

The new Corps was therefore combatant, as previous experience had proved that all engineers must be fighting soldiers. From the first it was intended that the officer personnel should consist of qualified mechanical and electrical engineers, who would be graded as 1st, 2nd, 3rd, or 4th class, but later it was found necessary to introduce an ungraded section of officers not so highly qualified. The rank and file consisted of armament artificers, armorers, fitters, and various other artisans covering nearly sixty different engineering trades.

Britain's Institutions of Mechanical and Electrical Engineers were both keenly interested; indeed, they were the inspiration of this great idea.

Both Institutions had elaborate records and had been in touch with their own members since the beginning of the war. In the words of one secretary, engineers of high technical skill who were "peeling potatoes in the infantry," had been taken out and used where their skill was required. The Institution of Mechanical Engineers alone had a membership of more than 20,000, so it was natural that the Adjutant General of the

NOTE: This article is published through the courtesy of British Information Services, 30 Rockefeller Plaza, New York 20, N. Y.



HIGH-SPEED ASSEMBLY OF TRANSPORT TRUCKS AT AN R.E.M.E. MIDDLE EAST DEPOT (One of the many jobs of the Royal Electrical and Mechanical Engineers in the Middle East is the assembling, servicing, and delivery of transport trucks. The job is done at dockside in record time.)

Forces looked to these engineering organizations for help and suggestions when the new Corps was formed.

He got these in full measure but the Institutions were able to do much more—they co-ordinated the demands for engineers both for the Forces and for industry, without overlapping. The task was gigantic, but it was undertaken and completed with the minimum of friction. And so the story of the youngest Corps in the British Army is already one of great achievement.

FIRST GREAT TEST IN EGYPT

Egypt was the first great test, and it can now be said that never in the history of the British Army, from Alamein onward, has it fought with more efficiently repaired weapons. Guns which developed faults, tanks which broke down, wireless sets, predictors, inaccurate range finders—all were dealt with by skilled men who knew their jobs.

The greatest artillery barrages of the war in Africa were laid down effectively, and these were followed by regiments and tanks which never hesitated in their chase of the fleeing German panzers; and again, behind these, the endless columns of vehicles rolled on, even under some of the worst conditions that mechanical transport has ever been called upon to surmount.

Organization had triumphed. Creation of the R.E.M.E. meant far more than just the founding of a new Corps or the introduction of a new badge. (The badge comprises the letters R.E.M.E. supported on a laurel wreath, surmounted by Royal crown, and contains in its center a replica of a pair of calipers as an indication of accuracy.) It brought a new organization into existence in a branch of war administration in which the Germans had earlier been claimed to be masters.

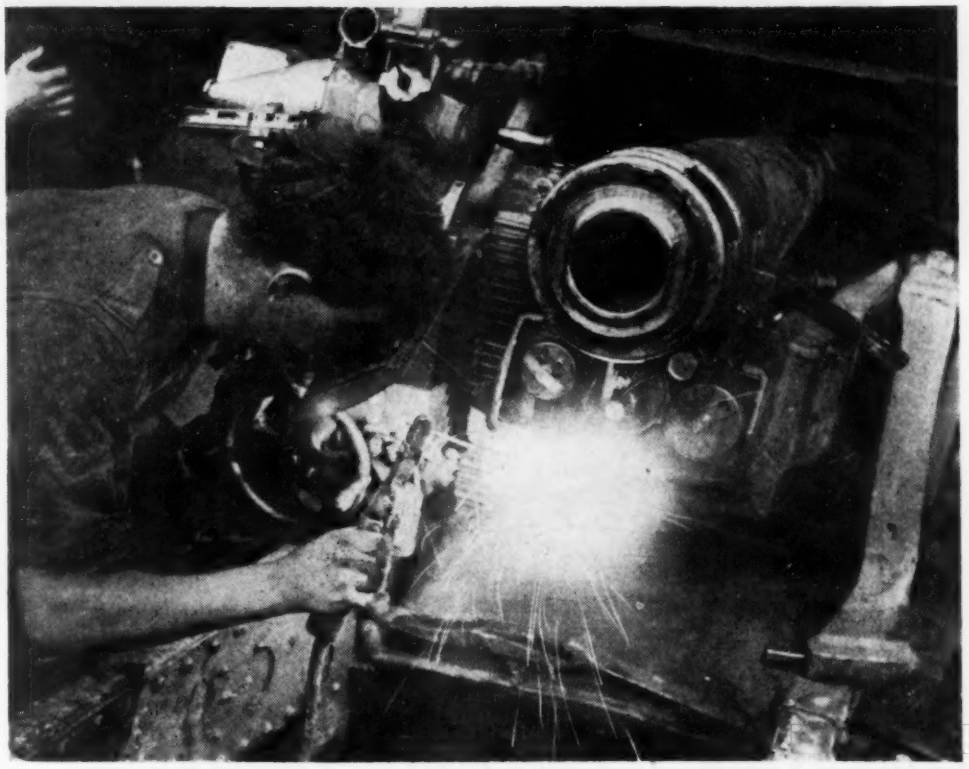
Centralizing the engineering services produced not only the pooling of skilled men and their resources, but it gave wide scope to a system which in a smaller way had shown promise of success. This system of echelon repair services in the field, was introduced early in the first world war by the engineering branch of Britain's Royal Army Ordnance Corps and later was adopted by the Germans.

ECHELON REPAIR SERVICES

Every unit which used mechanical or scientific equipment had now a highly trained, well-equipped detachment capable of maintaining it in action. Furthermore these detachments were independent and worked on a system of mobile workshops capable of a high degree of operational flexibility. It was no longer necessary for the infantrymen, the tankmen, the gunners, the sappers, and the signalmen to perform more than the barest of maintenance work; the complexity of modern weapons had made the new system necessary.

The system of repair and recovery work used so successfully in Egypt is now established everywhere. By means of this flexible echelon system, a small detachment of trained men can get a broken-down tank on the move by replacing the damaged engine or equipment with a new assembly, and have the broken apparatus sent back to a workship which has the facilities for its repair. The replacing of engines in tanks has been reduced by the skill of R.E.M.E. to a fraction of the previous time.

Base shops, magnificently equipped with the most modern tools and machinery, can effect any and every repair, and they are also capable of making spare parts if their local manufacture is necessary. The third line is almost as well equipped as a base workshop but it is designed to be movable and provides support to second-line workshops by undertaking the overflow of repairs with which the latter was unable to cope due to pressure of work, nonavailability of the correct spares and



WELDER AT WORK ON THE CRADLE OF A 25-POUNDER GUN IN AN R.E.M.E. WORKSHOP IN ITALY
(View was taken when the Fifth Army was breaking through the German positions on its advance to Rome.)

equipment. The third-line workshop is also equipped to repair assemblies by replacing unserviceable components. This is a secondary function which is only effected on instructions from higher authority, should it be necessary to augment the available stocks of new and repaired assemblies held by the R.A.O.C.

The two forward echelons do all the work possible "on the spot."

Thus it will be seen that the whole basis of modern repair work is to replace damaged apparatus with serviceable assemblies and leave the heavy repair work to the workshops outside the fighting zone, to replace a damaged engine with a new one and leave the repair of the damaged engine to a shop which has more time and greater facilities.

By a scientific grading of the jobs which each echelon can do, and by equipping them with the machinery and spare parts necessary for their tasks, their capacity as well as their mobility has been maintained. R.E.M.E. was planned on these lines and has proved to be the most efficient organization that could be developed.

TREATING A 25-POUNDER GUN WITH CAMOUFLAGE PAINT BEFORE LEAVING R.E.M.E. WORKSHOPS

More than 13,000 members of the two Institutions now hold commissioned rank, while the rank-and-file personnel has been drawn from garages and from industry. Artificers, armorers, fitters, artisans, radio mechanics, and craftsmen (the new title for an R.E.M.E. private soldier), are the best that industry could produce. They have worked long hours under arduous conditions so that the Army may fight with efficient weapons. They have allied the skill of the factory with native talent for improvization, and many stories are told of the almost fantastic difficulties they have overcome.

CONTRIBUTIONS OF THE R.E.M.E. TO LAND WARFARE

From these engineers, working in Egypt, Germany, Burma, Russia, and on every operational front, have come a flow of ideas for new weapons and new devices which have had decisive effect on the land warfare.

Perhaps the R.E.M.E's greatest pride is that it is a combatant Corps, and it has fought alongside the men of the armored corps, the gunners, and the infantry. Many honors and awards have already been earned.

The senior R.E.M.E. officer in the Division has the title of Commander R.E.M.E. and commands 1000 officers and men. His task is to advise the Divisional Commander on mechanical matters concerning repairs and maintenance. The next higher formation is the Corps where there is a Deputy Director of R.E.M.E., whose rank is that of Colonel and who is a senior R.E.M.E. staff officer of the Corps. His staff is made up of specialists in the various types of equipment.

Higher again is the Army, which may be made up of two or more Corps, and here the chief R.E.M.E. officer normally holds the rank of Brigadier. Finally, at the G.H.Q. there is the Director of Mechanical Engineering who is a Brigadier or Major General, and who controls the activities of some 25,000 officers and men.

The youngest Corps in the British Army has won its spurs

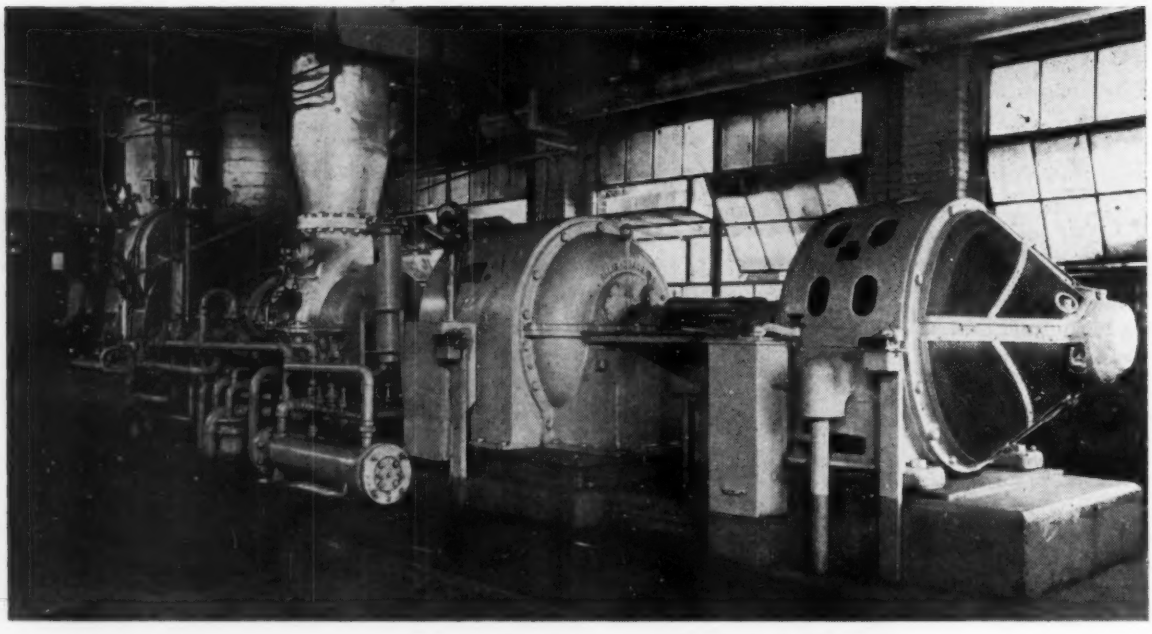


FIG. 1 A SUN OIL COMPANY 40,000-CFM TURBOCOMPRESSOR INSTALLATION WITH MOTOR STARTER

Operating Experience With the GAS TURBINE

Report on Use as Propulsion Equipment for Axial Air Compressors at Sun Oil Refineries

By ARTHUR E. PEW, JR.

SUN OIL COMPANY, PHILADELPHIA, PA.

GENERAL FACTS

PRIOR to 1936, Sun engineers, working in conjunction with the Houdry Process Corporation, adapted the Brown-Boveri gas turbine and axial compressor to supply air in large quantities and at comparatively high pressures for catalyst regeneration in the Houdry process of catalytic cracking. In the latter part of 1936, at the Marcus Hook, Pa., refinery of the Sun Oil Company, the first successful large gas-turbine unit in the United States was placed in operation.

In the operation of the Houdry catalytic process for aviation and high-octane gasoline, it is necessary, for maximum efficiency, to maintain the catalyst in a state of high catalytic activity. For plants charging to the catalyst approximately 10,000 bbl per day, the air requirements are approximately 40,000 cfm at 45 psig pressure. To obtain this quantity of air at this pressure, approximately 5600 hp is required.

A brief description of the Houdry catalytic-cracking operation, using the gas turbine, is necessary for an understanding of the performance records which are given hereinafter.

Oil is vaporized and passed through a catalyst. As one of the results of the chemical changes which occur, carbon is deposited on the catalyst. The efficiency of the catalyst is lowered by such deposits, which must be periodically removed. The catalytic containers are arranged so that the operation of carbon removal is continuous, on a cycle basis, certain containers being regenerated while others are operating on the oil cycle. The cycles from container to container are automatically controlled on a predetermined basis. The carbonaceous deposit is oxidized by the air from the compressor, and the products of combustion are passed to a gas turbine which in turn drives the axial compressor supplying air at 45 psi pressure to the catalyst-regeneration units. The heat content of the products of regeneration exceeds the energy necessary for the compression of the regeneration air. The excess is recovered as electric power and steam for use in the process. In the usual installation, gas temperatures at the turbine inlet are 875 to 950 deg F and are exhausted at about 550 deg F. Inlet pressure to the turbine is about 40 psig, and outlet pressure of the compressor is about 50 psig.

EXTENT OF USE

As of this date, there are in use in the United States, twenty-six gas-turbine units on Houdry cracking plants. Twelve units are of 23,000 cfm normal rating, thirteen units of 40,000 cfm, and one of 60,000 cfm rating.

Table 1 lists present installations in the United States.

Seven gas turbocompressor units have been installed in Sun Oil

Contributed by the Oil and Gas Power Division and presented at a meeting of the Chicago Section, Chicago, Ill., June 18, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

TABLE 1 SUMMARY OF TURBOCOMPRESSORS IN SERVICE ON STATIC-BED HOUDRY UNITS

Company	Location	Turbocompressors No.	Nominal rating, cfm	Manufacturer
Sun (11–4)	Marcus Hook, Pa.	1	40000	Brown-Boveri
Magnolia	Beaumont No. 1, Tex.	1	23000	Brown-Boveri
Sun (12–3)	Marcus Hook, Pa.	1	40000	Brown-Boveri
Socony	Trenton, Mich.	1	23000	Allis-Chalmers
Socony	Brooklyn, N. Y.	1	23000	Allis-Chalmers
Sun	Toledo, Ohio	1	40000	Allis-Chalmers
Magnolia	Beaumont No. 2, Tex.	1	40000	Allis-Chalmers
Socony	Buffalo, N. Y.	1	23000	Brown-Boveri
Socony	E. St. Louis, Ill.	1	23000	Brown-Boveri
Socony	Augusta, Kan.	1	23000	Allis-Chalmers
Socony	Paulsboro, N. J.	1	23000	Brown-Boveri
Sun (12–3 Ref.)	Marcus Hook, Pa.	1	23000[a]	Allis-Chalmers
Sun (10–3)	Marcus Hook, Pa.	2	40000	Allis-Chalmers
Tide Water	Bayonne, N. J.	1	60000	Allis-Chalmers
Socony	E. Chicago, Ind.	1	23000	Allis-Chalmers
Std. Oil Calif.	El Segundo, Calif.	1	40000	Allis-Chalmers
Gulf Oil Corp.	Port Arthur, Tex.	1	40000	Allis-Chalmers
Sun (15–1)	Marcus Hook, Pa.	1	40000	Allis-Chalmers
Sinclair Ref.	Houston, Tex.	1	40000	Allis-Chalmers
Magnolia	Beaumont No. 3 and No. 4	2	23000	Allis-Chalmers
Sinclair Ref.	Corpus Christi, Tex.	1	40000	Allis-Chalmers
Southport Pet.	Texas City, Tex.	1	40000	Allis-Chalmers
Std. Oil Ohio	Cleveland, Ohio	1	40000	Allis-Chalmers
Std. Oil Ohio	Cleveland, Ohio	1	23000	Allis-Chalmers

Summary:

Nominal rating, cfm	Number
23000	12
40000	13
60000	1
Total	26

[a] 23,000-cfm casing with blades cut for 16,000-cfm output.

TABLE 2 TURBOCOMPRESSOR INSTALLATIONS, SUN OIL COMPANY

Location	Capacity std, cfm	Rpm	Means of starting	Date in service	Type thrust bearing
Marcus Hook 11–4[a]	40000	5180	Motor	Dec., 1936	Angular contact ball[c]
Marcus Hook 12–3[a]	40000	5180	Motor	July, 1939	Angular contact ball[c]
Toledo 3[b]	40000	5180	Motor	Aug., 1939	Angular contact ball[c]
Marcus Hook 12–3[b]	16000	6050	Turbine	Nov., 1940	Angular contact ball
Marcus Hook 10–3[b] N	40000	5180	Turbine	Dec., 1940	Angular contact ball[c]
Marcus Hook 10–3[b] S	40000	5180	Turbine	Jan., 1941	Angular contact ball[c]
Marcus Hook 15–1[b] S	40000	5180	Turbine	Aug., 1943	Kingsbury

[a] Manufacturer: Brown-Boveri.
[b] Manufacturer: Allis-Chalmers.
[c] Angular contact bearings removed; Kingsbury installed since 1943.

NOTE: All compressors 45 psi discharge pressure.
All units have 1500-hp synchronous-motor generators except 16,000 cfm has 500 hp.

TABLE 3 GENERAL DETAILS OF GAS TURBOCOMPRESSORS

Capacity compressor unit (based on 60 F), cfm	23,000–60,000
Suction pressure (based on 60 F)	Atmospheric
Discharge pressure, psig	45
Turbine gas quantities, 40,000-cu ft size, lb per min	3170
Pressure, turbine inlet, psig	40
Temperature, turbine inlet, deg F	800–950
Speed of set, rpm	5180
Weight of set, 40,000-cu ft size, lb.	70,000

refineries, the first one in 1936, and the most recent in 1943. Table 2 lists pertinent data on these units.

DESCRIPTION OF SUN UNITS

The gas-turbocompressor units, as used by the companies listed in Table 1, are all of the same general design, other than capacity. The principal specifications are given in Table 3.

Table 4 lists the equipment required for the 40,000-cfm turbocompressor units as installed at the Sun Oil Company.

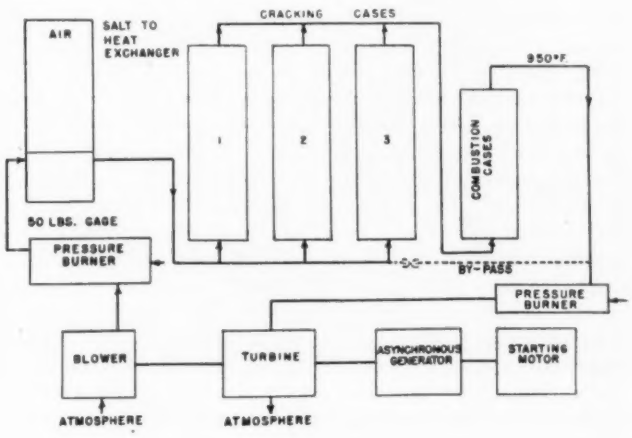


FIG. 2 AIR-FLOW SHEET

TABLE 4 EQUIPMENT 40,000-CFM TURBOCOMPRESSOR UNITS OF THE SUN OIL COMPANY

Gas turbine	Brown-Boveri, or Allis-Chalmers	6200 hp-950 F, reaction type, 5 stages
Compressor	Brown-Boveri, or Allis-Chalmers	Axial type, 20 stages
Governor and oil pump	Brown-Boveri, or Allis-Chalmers	.....
Auxiliary oil pump	Brown - Boveri, Roper, Allis-Chalmers	.....
3 Per cent overspeed valve	Brown-Boveri, Allis-Chalmers, Republic	.....
10 Per cent overspeed valve	Brown-Boveri, or Allis-Chalmers	.....
Oil coolers	Andale, or Griscom-Russell	.....
Oil filter	Nugent cloth filter (emergency) Shriver blotter press (normal operation)	
1500-Hp synchronous motor	Allis-Chalmers 2300 v-1792 rpm	
Starting units	Motors, Allis-Chalmers, or General Electric; steam turbines, Moore	.....
Reduction-gear unit	Moore	Between starter and 1500-hp motor
Reduction-gear unit	Falk herringbone, or Brown-Boveri	Between 1500-hp motor and turbocompressor, 5166 to 1800

TABLE 5 MATERIALS USED IN TURBOCOMPRESSOR UNITS, SUN OIL COMPANY

Sealing strips	18 Chrome-8 nickel (originally were nickel)
Gas-turbine blades	Stainless steel
Compressor blades	Nickel steel
Gas-turbine spindle	Chrome-nickel-steel forging
Gas-turbine cylinder	Molybdenum cast steel
Compressor spindle	Steel forging
Compressor cylinder	Cast iron
Bedplate	Cast iron

TABLE 6 SUN OIL COMPANY SUMMARY TURBOCOMPRESSOR OPERATION TO MAY 31, 1945

Location plant	Operating days	Days off account turbo trouble	Total days	Per cent time turbo trouble
11-4	2607	50	2657	1.88
12-3 C	1900	21	1921	1.09
12-3 R	1413	45	1458	3.10
10-3 N	1404	34	1438	2.36
10-3 S	1365	29	1394	2.08
15-1 S	569	0	569	0.00

METHOD OF OPERATION

Fig. 2 shows diagrammatically the arrangement of a gas turbine, blower, generator, and starting motor, or turbine interconnected with a catalytic-cracking unit. In starting up, the turbine is rotated at approximately 2000 rpm for several hours by means of the starting motor or starting steam turbine, while bearings are warmed up and equipment checked. During this time the air delivery from the compressor is circulated through a by-pass to the turbine. After partial speed, i.e., 25 to 30 per cent of normal, has been reached and the units checked, the temperature is brought up by the pressure burner ahead of the turbine. The volume of air being circulated and the pressure are raised over a period of 8 to 10 min by gradually bringing the unit up to its full speed of 5180 rpm. The heat of the discharge air is then gradua ly raised by the air heater located on the discharge side of the compressor, and the air thus heated is passed to the catalytic cases. Following this, the gases from the catalytic-cracking case, resulting from the regeneration of the carbonaceous deposits, supply the energy for operation of the turbocompressor unit, and pressure burners are shut off.

Under normal operating conditions, the amount of excess power supplied to, or developed by, the unit depends upon the type of catalytic-cracking reaction being practiced, i.e., with increase in carbon deposition, power will increase.

In general, with air temperature at 60 deg F to the compressor and with gas temperature to the turbine at 950 deg F, the 40,000-cfm units will generate up to 900 kw excess over required power for driving the compressor.

Table 5 shows the material used in the construction of the principal parts of the turbine and compressor units.

SERVICE RECORD

Table 6 shows the number of operating days on each of six Sun Oil installations in relationship to the number of days shut down because of turbocompressor difficulties. The plants are listed in the order of their installation.

Under the heading "Days off account turbo trouble" is included time chargeable to the complete turbocompressor unit and the equipment in connection therewith necessary for operation. The time shown represents the time required for making repairs. It is believed by the operating division of Sun Oil Company that time off due to turbine troubles and troubles in connection with turbines has not been excessive under the conditions encountered.

Table 7 shows failures causing outages in the order of their prevalence.

TABLE 7 FAILURES CAUSING TURBINE OUTAGES, SUN OIL COMPANY

1 Bearings:
- Thrust bearings.
- Spring rings (roller bearings).
- 1500-Hp-motor bearings.

2 Lubrication:
- Dirt in oil sprays, causing bearing failures.
- Water in oil (condensate), causing bearing failures.
- Main oil pumps—broken shaft spline as result of bearing failures.
- Auxiliary oil pump—failure to start when main pump failed.

3 Blades:
- Loose blades—latest design with integral root, no loose blades in 22 months on one unit.
- Erosion—gas-turbine blades.

4 Air-seal strips (failure does not necessarily cause shutdown):
- Material.
- Rubbing, due to change in alignment.
- Expansion joints—harness.

5 Explosions:
- 11-4 By-passing air into oil vapors—experimental case.
- 12-3 Reformer—air by-passed into oil vapors.
- 12-3 Cases—gas explosion—gas burner opened by mistake.
- 10-3 Dirty oil burner—no atomization.

6 Miscellaneous:
- Foreign objects in compressor or turbine.
- Failure to synchronize before cutting motor in when starting unit.

Table 8 classifies failures causing turbocompressor outages in relation to number of failures and days lost for each type of failure.

It will be noted that out of 46 failures, 29 were caused by bearing trouble, and that out of 179 days lost time from all causes, 101 days were due to failures of bearings. In this connection, Table 2 shows the type of bearings installed in Sun Oil units. It was early found that the angular-contact ball-bearing type of thrust bearing was not satisfactory for the conditions encountered; and as shown in Table 2, the angular-contact bearings have all been replaced with Kingsbury-type thrust bearings, with the exception of one unit at Marcus Hook which is now being changed. There have been no thrust-bearing failures or bearing repairs since the Kingsbury type were installed.

The first Kingsbury bearing was installed on a Sun Oil unit in June, 1942, and has been in satisfactory operation since that time. The other units were converted at various times in the interval. In view of the record of no failures, it is believed reasonable to assume that this type of bearing is satisfactory for these units. It may fairly be assumed that had Kingsbury

TABLE 8 FAILURES CAUSING TURBOCOMPRESSOR OUTAGES, SUN OIL COMPANY

	Bearings		Lubrication		Blades		Air seals		Explosions		Miscellaneous		Total	
	No.	Days	No.	Days	No.	Days	No.	Days	No.	Days	No.	Days	No.	Days
11-4	18	43	...	..	...	..	...	..	1	5	1	2	20	50
12-3C	4	12	...	..	1	4	1	3	1	2	...	..	7	21
12-3R	4	31	3	14	...	..	...	..	...	..	...	..	7	45
10-3N	3	15	3	14	...	..	...	..	1	5	...	..	7	34
10-3S	...	..	...	..	3	15	...	..	...	..	2	14	5	29
15-1	...	..	...	..	...	..	...	..	...	..	...	..	0	0
Total	29	101	6	28	4	19	1	3	3	12	3	16	46	179

thrust bearings been used from the beginning, the total time lost would have been reduced approximately 60 per cent.

It will be noted from Table 8 that lubrication difficulties were responsible for a loss of 28 days with 6 failures due to lubrication. Lubrication difficulties were caused by dirt in the oil sprays, condensate in the oil, broken shafts in main oil pumps as the result of bearing failures, and failure of auxiliary oil pumps to start when the main pump failed. It is believed that lubrication difficulties have been largely overcome by the installation of blotter presses, and no lubrication failure has occurred since these installations were made.

Failure of blades in either the compressor or the turbine was responsible for 4 shutdowns of 19 days' lost time. These failures are caused by blades becoming loose as a result of an original design in which the blade was not integral with the root. Later designs by the Allis-Chalmers Company have provided an integral-root blade, and no trouble has been observed in over 22 months of operation in a Sun unit with this type of blade. There has been some trouble noted from erosion of the gas-turbine blades due to fine particles of catalyst being present in the gases or small deposits of carbon dust. Experimental work is being done to eliminate this condition by trapping the air entrances to the turbine. The erosion noted has not been of sufficiently great extent to be an important problem.

Table 8 also indicates one shutdown of 3 days' duration for failure of air seals. Air-seal strips are subjected to rubbing due to change in alignment and gradually wear out. However, these may be repaired during a normal shutdown without excessive difficulty and are not considered as being a weakness which might necessarily cause shutdowns. However, improvements in air seals become more important as shutdowns for other causes are eliminated.

There have been 3 shutdowns of 12 days' duration total due to explosions. These explosions are not due to turbine design, but are the result of errors in operation or failures in handling other parts of the equipment serviced by the turbines. None of the three explosions was of sufficient intensity to rupture the equipment.

Under the column headed "Miscellaneous," there were 3 shutdowns of 16 days' duration due to errors in maintenance. In one case a foreign object was left in the air compressor causing blading to be stripped.

Summarizing; bearing failures, lubrication failures, and blading failures are the three principal causes of shutdowns, and

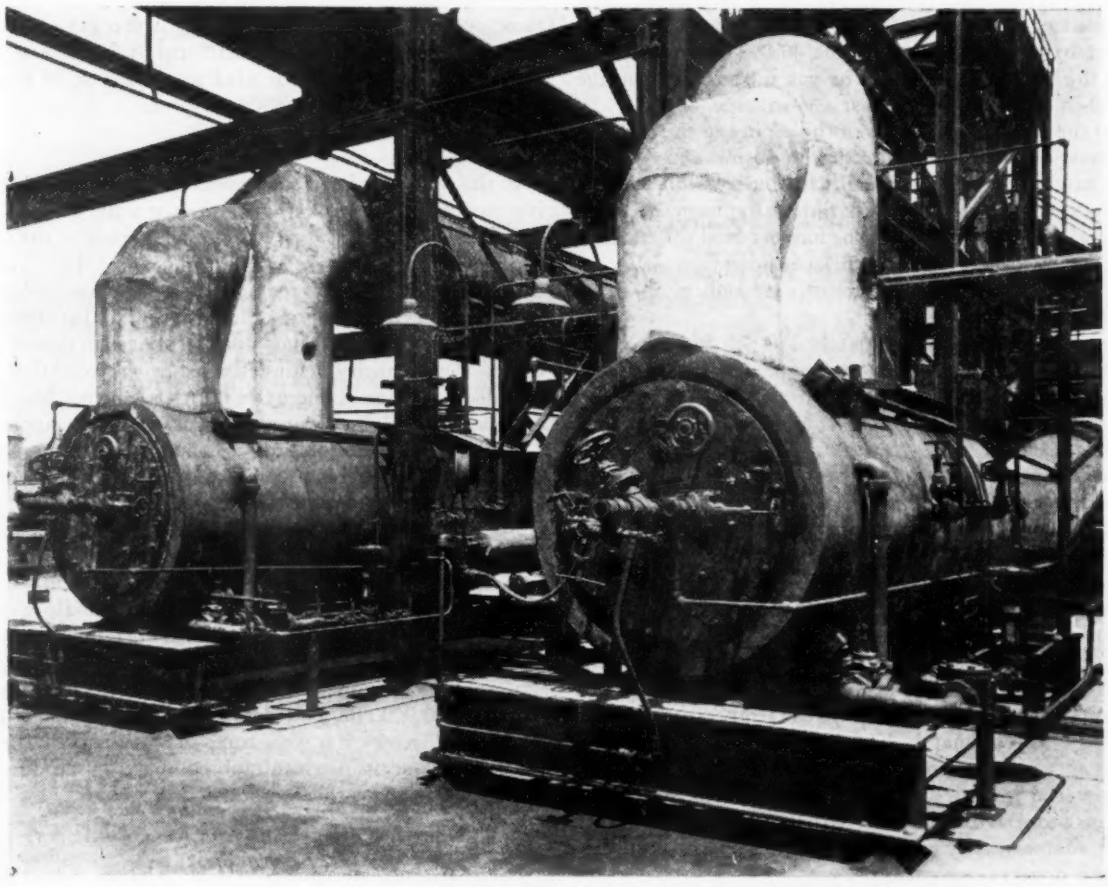


FIG. 3 COMBUSTION CHAMBERS USED IN A SUN OIL COMPANY HOUDRY PROCESS UNIT
(Shown are burners, air discharge line from compressors, lines to catalytic cases, and return lines to gas turbine.)

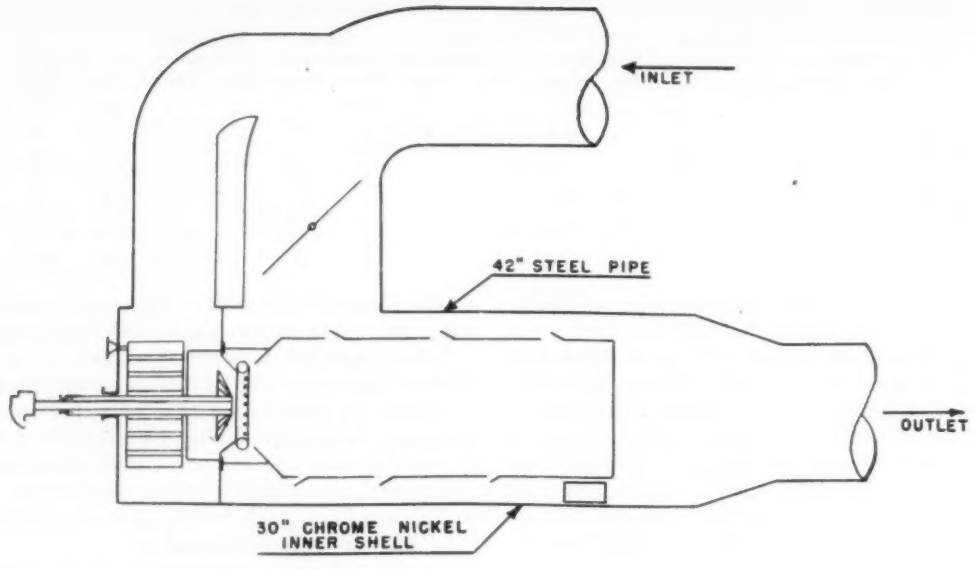


FIG. 4 ARRANGEMENT OF COMBUSTION CHAMBER

accounted for 148 days' lost time out of a total of 179 days, and for 39 shutdowns out of a total of 46. It is believed that the changes described have satisfactorily and substantially eliminated these causes of shutdowns.

IMPORTANT CONSIDERATIONS IN CONNECTION WITH INSTALLATION OF GAS-TURBINE UNITS

Probably the most important consideration with regard to installation arrangement of gas-turbine units is ample provision in the piping to reduce piping strains to a minimum. The piping to the turbine and compressor units is unusually large, the air inlet to the compressor on the 40,000-cfm machine is 36 in. and the air outlet 30 in. The gas inlet to the turbine requires a 30-in. pipe and the exhaust a 36-in. pipe.

Owing to the high temperatures of the piping to the turbine, provision must be made to handle the expansion and contraction as the machine is relatively light in construction and the speeds high, making it essential that the alignment be accurately maintained. The design of the burners used for starting the turbocompressor requires careful consideration. Fig. 4 shows the arrangement of the combustion chambers ahead of the air heater and the turbine.

Air at a temperature of approximately 350 deg F, and 45 psi pressure from the outlet of the air compressor enters the combustion chamber through a 30-in. pipe. The air flow is divided at this point, a portion of it passing through an air register and thence to the oil burner for combustion. The balance of the inlet air passes through a control damper and around the outside of a 30-in. chrome-nickel shell inserted in the 42-in. steel pipe. The inner shell has a number of perforations so arranged as to cause an infiltration of air into the inner shell in such a manner as to create a swirling and mixing action within the inner shell and thereby provide cooling of the shell walls. The products of the combustion and the excess air commingle at the outlet of the 42-in. pipe section and pass therefrom to the catalytic cases for regeneration of the catalyst The temperature of the mixture is approximately 950 deg F, and the temperature within the inner shell is approximately 2000 deg F. The air capacity of the burner is approximately 40,000 cfm at 45 psi pressure. No refractory material is used. This type burner has operated for a number of years with entirely satisfactory results. The design is an adaptation by Sun Oil engineers from the basic design of Brown-Boveri Corporation.

Arrangements of valves, control instruments, etc., have been worked out on the basis of experience and have given satisfactory results. Detailed description of the installation is considered too lengthy to be incorporated in this report However, it may be said that the installations are not complex and involve no special operating or maintenance difficulties.

MAINTENANCE COSTS

The cost of maintenance and repairs of the various units listed in this report have varied from a high of approximately $1000 a month to a low of $300. Maintenance and repairs may be conservatively estimated on units as they are now developed as not in excess of 3 per cent per year of capital investment. The most costly repair is the reblading of the gas turbine which, under present conditions, is estimated at $13,000 of which approximately $12,000 is for blades. The cost of cleaning the units has averaged about $300 per year.

SUMMARY

In the opinion of Sun's engineering organization, the operating records of the gas-turbocompressor units at Sun Oil plants have been such as to justify the continuation of the use of this type of equipment in future installations. The cyclic operation of the Houdry units requires the steady flow of regeneration air under varying pressure differentials and also changes in the system pressure differentials due to changes in operating conditions. The quantity of air delivered by the axial-flow compressors discussed herein fluctuates less than one per cent for 20 per cent variation in discharge pressure as opposed to approximately 20 per cent or more for similar changes in pressure conditions in the case of centrifugal compressors. There has not been offered a suitable centrifugal compressor nor a prime mover to replace the gas turbine which meets the requirements of economy and efficiency essential in connection with the regeneration of catalysts in the Houdry catalytic operation.

In this application, it is necessary to handle gas at high pressures and in large quantities, utilizing combustion products resulting from the chemical reactions obtained from the catalytic cracking processes. It is obvious that a catalytic plant requiring 40,000 cfm at 45 psi pressure could not obtain high economic efficiency if it were necessary to compress this amount of air without using resultant combustion products as the source of power for the compression of the air.

ACKNOWLEDGMENT

The assistance of Messrs. C. H. Thayer, Chief Engineer, Sun Oil Company, and H. E. Melton, Assistant Superintendent, Power Division, Sun Oil Company, in the preparation of this report is acknowledged and appreciated by the author.

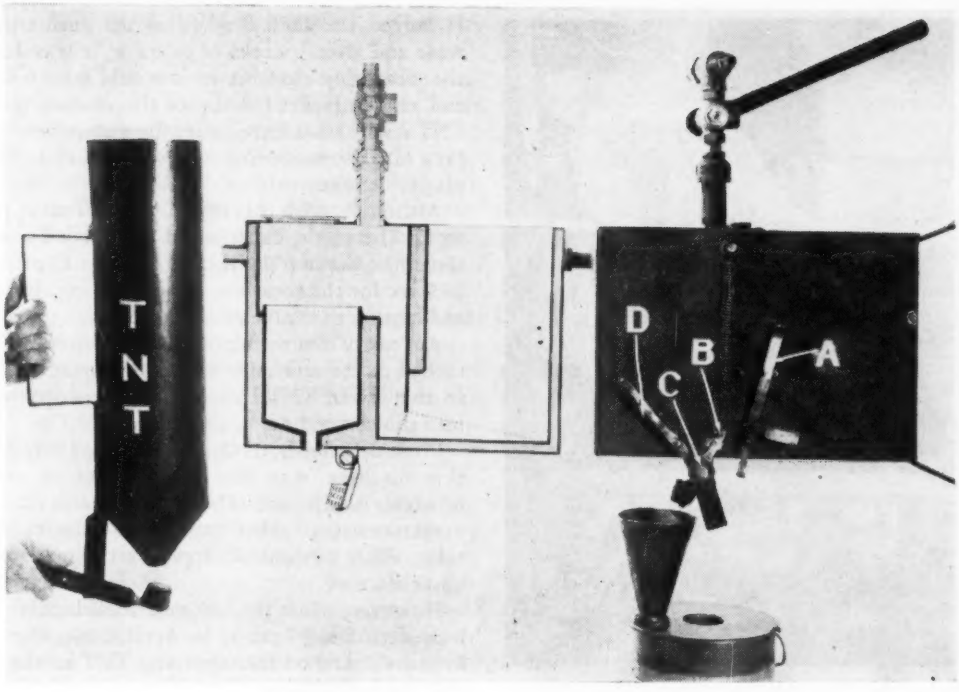


FIG. 1 ORIGINAL AND EXPERIMENTAL MODELS OF TNT POURING MACHINE, AND A CROSS SECTION THROUGH ONE-CUP UNIT

VOLUMETRIC POURING MACHINE

A Development for Mine, Projectile, and Bomb Loading

By L. A. QUAYLE

CHIEF ENGINEER, THE SHERWIN-WILLIAMS DEFENSE CORPORATION.[1] MEMBER A.S.M.E.

IN June, 1943, the author suggested the multiple loading of antitank mines with TNT by volumetric pouring to Dr. E. E. Ware, general manager of The Sherwin-Williams Defense Corporation, prime contractors of the Illinois Ordnance Plant. The type of pouring machine suggested depended partially for its success on the ability of a rubber stopper to seat tightly against the orifice of a measuring cup under all conditions of operation. After demonstrating, by the use of the TNT container with stopper valve, shown at the left in Fig. 1, that a rubber stopper had the necessary elasticity to flex off frozen TNT from its seating end and always make a tight seat against the outlet of the container, permission was given to construct a small machine having one measuring cup.

DEMONSTRATING THE ONE-CUP EXPERIMENTAL MACHINE

This one-cup experimental machine is also shown in Fig. 1, as well as a cross section through it. It was nothing more than a small, welded, jacketed, steel box with a partition in it which divided the reservoir section from the measuring chamber, and a simple valve mechanism which pressed a rubber stopper against the measuring-cup-orifice seat and, when the cup was to be emptied, snapped it away from the seat.

In operation, TNT was poured into the reservoir from a rubber bucket, and the level of the TNT was allowed to vary from approximately 1 in. below the top of the measuring cup to 1 in. above the screened opening between the reservoir and measuring chamber. The air pressure in the measuring chamber was reduced below atmospheric by opening the three-way cock which connected it with the vacuum-cleaner header in the draw-off bay of the melt-pour building, where this experimental machine was located. The TNT in the reservoir was forced to flow into the measuring chamber by atmospheric pressure until the cup was filled, and the level of the TNT was approximately $^1/_2$ in. above the top of the cup. Then the three-way cock was turned to cut off the connection to the vacuum header and, at the same time, allow air to enter the measuring chamber, which in turn caused the excess TNT to return to the reservoir.

The cup was emptied by pushing lever *A* until it disengaged crank arm *B* on shaft *C* and allowed the spring to pull the stopper quickly off its seat on the nozzle of the cup. The stopper was brought back to a closed position by pushing clockwise lever *D*, which had a projecting pin that engaged the crank arm *B*, until the lever *A* dropped back of crank arm *B* and locked it in place. Hot water was circulated through the jacket to keep the surfaces with which TNT came in contact above its freezing point. The wall, dividing the reservoir from the measuring chamber, was not jacketed until several hours of operation proved that the throat of the machine would plug up with frozen TNT and prevent it from flowing into the measuring chamber unless jacketing was provided. The operator could see when the measuring cup was full, when the excess TNT had drained below the top of the cup, and when the cup was empty, by looking through the glass window in the top of the measuring chamber.

[1] At the Illinois Ordnance Plant, Carbondale, Ill.

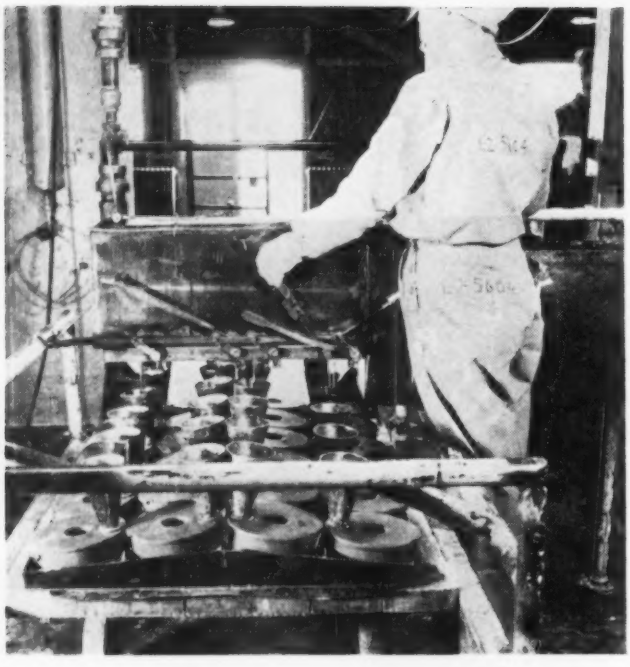


FIG. 2 MINE-POURING MACHINE LOADING 105 MM SHELLS

Although this experimental machine was very crudely built, it demonstrated the soundness of the principle of its design by: (*a*) Loading many thousand antitank mines before being replaced with a four-cup machine. (*b*) By the fact that the same fundamental principles of construction and operation were embodied in several larger machines made since. The fundamental principles of construction referred to are (1) the use of a number of measuring cups of equal volume; (2) the filling of the cups by partially exhausting the air from the measuring chamber; (3) the use of the rubber stopper valves for holding the TNT in the cups until they are to be emptied by snapping the stopper back out of the way of the TNT as it flows from the orifices.

A MINE-POURING MACHINE WITH FOUR MEASURING CUPS

The second mine-pouring machine was designed with four measuring cups and loaded several hundred thousand antitank mines, as shown in Fig. 2, before the schedule was changed to 105 mm shell-loading. The measuring chamber of this machine was connected to the vacuum-cleaner header by a rubber hose in the same manner as was the one-cup experimental machine.

We found that the small steady stream of TNT which flowed from the cup nozzles allowed the air to come freely out of the mine funnels, the area of the $^1/_8$-in-diam cup nozzles was less than one fourth of the area of the funnel spouts, and it was not necessary for the TNT stream to hit in the center of the funnel.

When mines poured with rubber buckets were sectionalized into quarters, cavities of considerable size were found in the body of the casts caused by trapped air. No such cavities were found in mines poured by the machine, and the machine-poured mines averaged several per cent heavier in weight than the bucket-poured mines, proving that the neck of the funnel does not plug with TNT and trap air as it does when pouring with a bucket.

The advantages of multiple-volumetric machine pouring having been demonstrated in the pouring of antitank mines, Dr. Ware decided to convert the mine-pouring machine to 105 mm shell pouring on the completion of the mine schedule. The measuring chamber was long enough for five cups of the capacity needed for 105 mm shells. The four antitank mine cups were removed and five cups 4.25 in. diam by 5.7 in. high, which held 4.46 lb of molten TNT, were welded in place. However, the shell holders on the push trucks were 6 shells wide and after 3 weeks of pouring, it was decided to lengthen the measuring chamber so it would pour 6 shells at one time, and also to jacket the top of the measuring chamber to stop TNT icicles from forming on the underside of the top and dropping into the measuring cups where they had at times partially plugged the cup orifices.

Although, with this model the TNT must pass over five cups to fill the sixth, experienced operators have repeatedly filled the nine rows of 6 shells each in 2 min 12 sec, or approximately 14.7 sec for the complete cycle of filling, leveling off, pouring, and closing the valve mechanism.

An easily removable splash pan was constructed and attached to the underside of the measuring chamber at this time so that when TNT splashed off the stoppers it would splash into the pan and not onto the shells.

From September, 1943, until April, 1944, during which time this machine was first pouring mines and then 105 mm howitzer shells, the TNT was poured into its reservoir by operators using rubber buckets which were filled from cooling tubs. This method of supplying the machine with TNT was unsatisfactory.

However, when the 105 mm shell-loading operations were moved to Load Line 1, in April, 1944, the following greatly improved method for supplying TNT to the pouring machine was put in operation.

IMPROVED METHOD OF SUPPLYING TNT TO LOADING MACHINE

The TNT after being feathered in the Dopp kettle was discharged into a water-jacketed tempering tank equal in capacity (1800 lb) to the Dopp kettle. The TNT was kept agitated with a pneumatic agitator while cooling in the tempering tank, and the reservoir of the pouring machine was kept filled by the operator who controlled both the Dopp-kettle valve and the valve which allowed the TNT to flow out of the tempering tank into the reservoir. Fig. 3 shows the pouring machine and tempering tanks in operation. Although two tempering tanks were installed, the operating department pre-

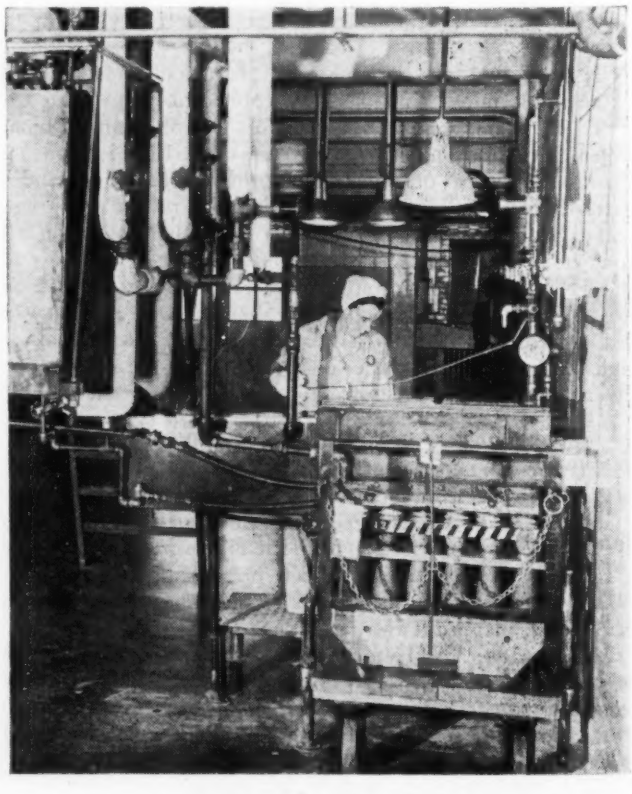


FIG. 3 POURING MACHINE AND TEMPERING TANKS IN OPERATION

ferred to use only one of them during this 8 months of operation.

Fig. 3 also shows the jacketed splash pan and hose connections to it. The unjacketed pan had to be removed after every few pours to clean out the TNT that solidified in it, to break off the TNT icicles that formed on the underside of the rubber stoppers and also on the underside of the splash pan around the rims of the holes through which the TNT streams passed. If these icicles were allowed to grow to a length where they would break off and drop into the shells there was a chance that they would be the cause of cavitation. Since the jacketed pan kept the space between the bottom of the measuring chamber and the top of the splash pan in which the stopper valves operate at a temperature above the freezing point of TNT, no icicles could form, also no TNT could solidify on the splash pan, hence no icicles could form on the underside of it, and no cleaning was required except on the Saturday night clean-up shift.

We have found that the water going into the jackets should be approximately 179 F, if the outgoing water is allowed to drop 176 F. Since the cup nozzles extend through the water jacket, they will tend to freeze sooner than any other part of the machine, therefore the machines are baffled so that the inlet water passes around the nozzles first, at a velocity of not less than 10 fpm, and then around the cups and through the measuring chamber jacket before going into the reservoir jackets, there being a total of ten passes from inlet to outlet. As a result, there are no cold spots to which the TNT can freeze. Since we must keep the jacket temperatures high enough to prevent the TNT from freezing and low enough to prevent the TNT from absorbing any appreciable amount of heat so no long crystals will be formed in the shells, it is necessary to work on the small temperature range of 3 or 4 deg, preferably from 179 F to 176 F. Tests showed that flows of from $2^1/_4$ to 7 gpm maintained proper jacket temperatures, the larger flows applying to the larger machines.

The jacket water for the pouring machines and tempering tanks is circulated by standard motor-driven hot-water-heating-system type pumps. The head against which the pumps operate is only the friction in the piping and water jackets and amounts to about 8 psi. The temperature of the jacket water is controlled by the use of standard temperature-control equipment which recirculates some of the water from the discharge back into the inlet line to maintain uniform temperatures.

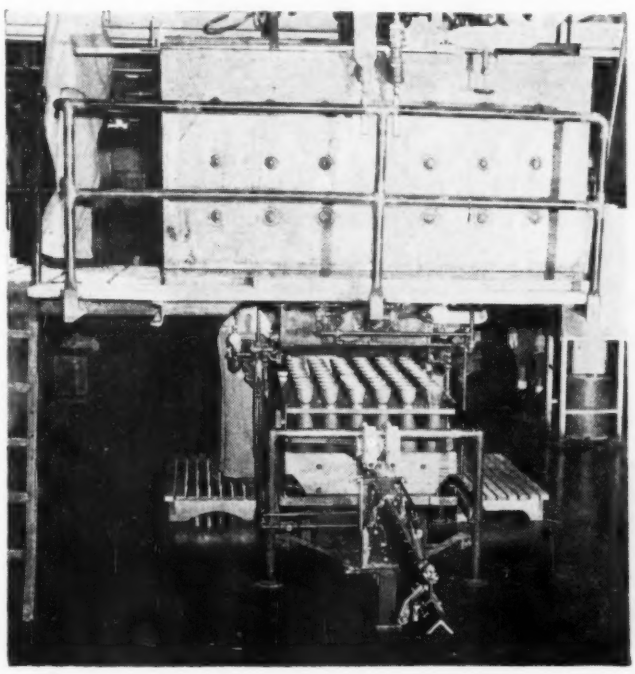


FIG. 4 VIEW OF BACK OF THIRD MACHINE CONSTRUCTED

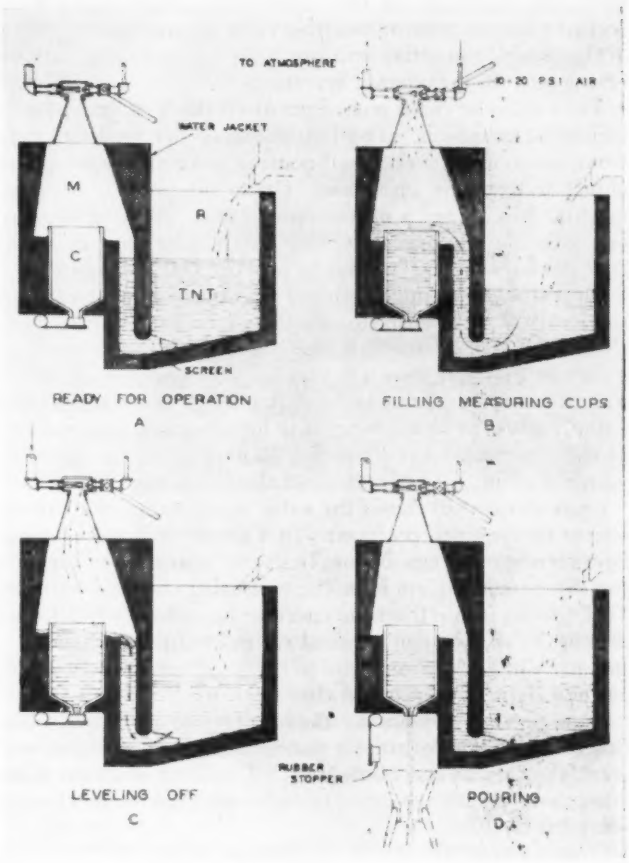


FIG. 5 CROSS SECTIONS SHOWING PRINCIPLE OF OPERATION OF VOLUMETRIC POURING MACHINE

THIRD MACHINE MAKES RISER POUR ON 105 MM SHELLS

The third machine constructed makes the riser pour on the 105 mm shells. In order to obtain a more compact machine and also one that would fill all six cups at once, the reservoir was placed at the side of the row of six cups instead of at the end of the row. Each cup was 4.5 in. diam × 4.75 in. high and poured approximately 1.6 lb of TNT through a 13/32-in-diam nozzle in 6 sec.

Fig. 4 shows a back view of the machine, the tempering-tank operator, and the indexing machine. A pointer welded inside of the reservoir is kept in view by the tempering-tank operator and shows him the highest point to which the level of the TNT should be allowed to rise. Starting with the TNT at this level, the cups can be filled from 3 to 4 times before the TNT is drawn down to the point where the vacuum breaks due to air being drawn into the measuring chamber from under the partition between the reservoir and the measuring chamber. However, the tempering-tank operator usually keeps a fairly steady flow into the reservoir while the machine is operating, inasmuch as a flow of 8.6 gpm for the first pour and 4 gpm for the riser-pour machine is the usual rate of pouring when fifteen to twenty push trucks with fifty-four 105 mm shells are loaded per hr.

A push truck with 54 empty shells weighs over 2000 lb and pushing and stopping them at each of the nine rows while they were being poured was no easy task. To eliminate this pushing-and-pulling operation, a pneumatic indexing machine was constructed. When the operator closes the valves on the pouring machine, the ram pushes the truck one row of shells forward and when she trips the valve for the pouring operation, the piston of the pneumatic cylinder returns ready for the next

push, the air valve of the pneumatic cylinder being interlocked with the pouring-machine valve mechanism.

One pouring-machine operator and one tempering-tank operator perform the pouring operations.

The number of shells poured per day is being stepped up with increasing schedules. The bottleneck of our loading operations has not been the shell-pouring since the pouring machines were put in operation. Up to the present time, this machine has loaded a maximum of 25,000 shells in one day; however, during one shift 9000 shells were loaded, which is at the rate of 27,000 per day or over 670,000 per month.

The rates of pouring mentioned are higher than we expected to be able to make with this small six-measuring-cup machine.

A cross section through the 105 mm top-pour machine, shown in Fig. 4, is shown in Fig. 5. Cross section (*A*) shows a section through the measuring chamber *M* and reservoir *R* of a single-row six-cup machine ready for operation with the TNT at the highest level it should be allowed to rise in the reservoir, i.e., 2 in. below the tops of the measuring cups *C*.

Cross section (*B*) shows the valve which supplies air to the ejector in the open position. This allows compressed air to flow through the ejector-supply nozzle into its Venturi tube thereby evacuating air from the measuring chamber until the TNT flowing into it from the reservoir has completely filled all the cups. The vacuum required in the measuring chamber of this machine varies from $\frac{1}{2}$ in. to 1.5 in. of mercury, depending on the height of the TNT in the reservoir.

Cross section (*C*) shows the compressed-air-supply valve closed and enough of the air returning through the ejector to break the vacuum and allow the TNT to level off in the measuring chamber, and the excess to return to the reservoir, the cups being left level full.

Cross section (*D*) shows the stopper valves in their open position, and the measured volume of TNT running into shells, bombs, or mines.

One good operating feature of this vacuum-type machine is that no TNT can be drawn into and spilled out of the cups if the operator forgets to close the stopper valves, because the open cup nozzles allow air to come into the chamber as fast as the air ejector removes it. Hence no vacuum is formed and no TNT can be drawn into the cups and spilled.

We are often asked what would happen if the operator should leave the vacuum valve open too long. It will be noted from the cross sections of the different models that the volume of the reservoir from 2 in. below the tops of the cups to the lowest point to which the TNT can be drawn without breaking the vacuum is about equal to the combined volume of the measuring chamber and cups, hence only enough TNT could be drawn into the measuring chamber to fill it. Also the maximum vacuum of 2 in. of mercury required by any of the machines will lift the TNT less than 19 in. If these two safeguards fail to work, the cold expanding compressed air passing through the ejector nozzle would immediately freeze any TNT that reaches it and plug up the nozzles and kill the vacuum. To clean the ejector nozzles would require less than 5 min, as the connections to the ejector are not tightened with a wrench.

DIFFICULTIES OF HAND-POURING

Comparison of Fig. 3 with Fig. 6 gives a partial idea of the difference in personnel required for machine-pouring in contrast with hand-pouring. Since the thread-cleaning operators and the shell-cleaning operators, not required when machine-pouring is used, were working in another building they are not shown in Fig. 6.

In the hand-pouring procedure, TNT was drawn from the Dopp kettles or melters into about fifteen tubs for a crew of the size shown. These tubs held about 180 lb and, after being filled, were pushed to positions along the wall of the drawoff bays where their contents was stirred either by hand paddles or by pneumatic stirrers until the TNT had cooled down to the proper temperature. Then the tubs were pushed by the operators to the pouring bays, some bays being as far as 60 ft from the draw-off bay. The tubs were tipped by turning the handwheel and the TNT poured into rubber buckets. The buckets containing from 15 to 20 lb of TNT were then carried to the

FIG. 6 TYPICAL SCENE WHEN HAND-POURING 105 MM SHELLS

push truck and for the first pour approximately 4½ lb of TNT was poured into each of 54 105 mm shells or 12 lb into 155 mm shells, the operator looking into each shell so she could see at what height to stop pouring. This operation was repeated three times on each truck of shells, only smaller quantities of TNT were poured on the second, third, and fourth pours.

It was necessary continually to break in new operators in order to keep the large crews filled, due to high absenteeism especially on Saturdays and Mondays, and also due to a fairly rapid turnover in this toxic operation. This resulted in a rather high percentage of rejections resulting from high and low pours. Since TNT rapidly solidified on the surfaces of the tubs and buckets and had to be broken off after every few pours, a noticeable reduction in the quantity of tub, bucket, and floor-pan scrap which had to be remelted was observed as soon as machine-pouring was put in operation. The amount of scrap, which was removed from floors and other locations, making it unusable and requiring it to be sent to the burning ground, was also greatly reduced.

TWO-POUR PROCEDURE OF SHELL-LOADING

On October 2, 1944, the loading of 155 mm shells by four separate pours from rubber buckets, in the manner shown in Fig. 6, was changed to loading by pouring twice, once with a first-pour machine and once with a top- or riser-pour machine.

The push trucks which are used for transporting the 155 mm shells hold twenty-four shells and are four rows wide and six rows long. The pouring machines pour two rows of four shells each and repeat three times to fill the twenty-four shells in the push truck.

The operator of the first-pour machine usually takes 55 sec to pour a push truck of twenty-four shells. Since each shell receives 14.5 lb, the machine pours 116 lb each cycle or 348 lb per truck. This is at the rate of 30.5 gpm. Allowing 55 sec to pour, 10 sec to push a truck into the machine, 8 sec to pull it out of the way of the truck coming into the machine, and 17 sec for a rest between pours, an operator can easily pour trucks on a 1.5-min schedule or 40 trucks per hr, or 6.96 tons of TNT per hr. If we pour 24 hr per day, on this schedule, 167 tons of TNT will be poured into 23,000 shells. Under the present schedule, we have only needed to pour a maximum of 11,400 shells per day.

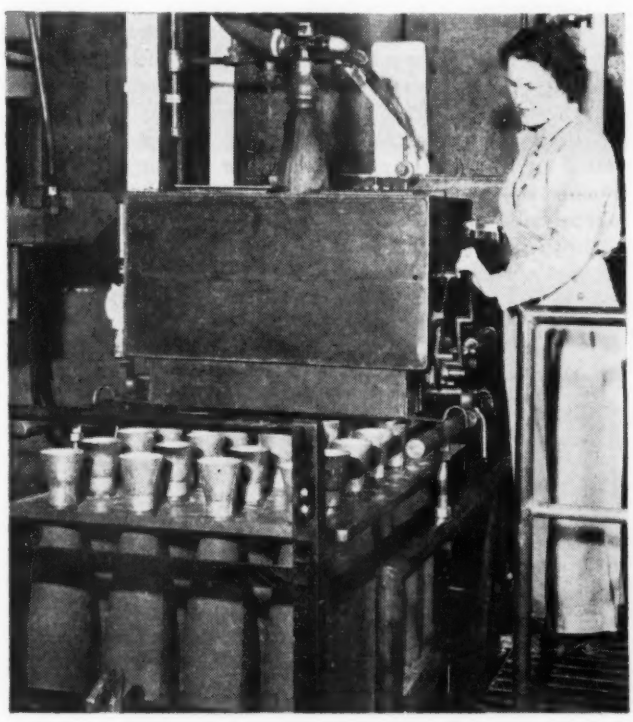


FIG. 7 FIRST-POUR MACHINE IN OPERATION

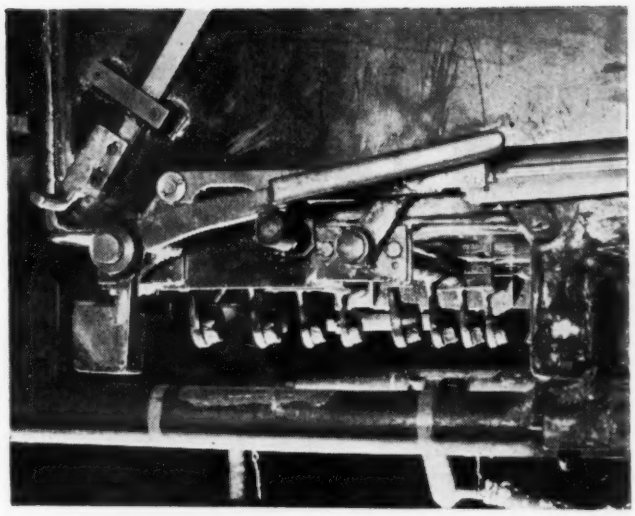


FIG. 8 STOPPER VALVES OF FIRST-POUR MACHINE

From the start, there has been a temptation to build pouring machines to pour all the shells in the push truck at one time, but the six- and eight-cup machines built have had more than sufficient capacity to take care of our schedules. Also experience taught us that to handle a substance as temperamental as TNT more uniform results could be obtained if the time required to pour a truckload of shells was kept at a minimum. In other words, if the TNT is kept flowing steadily through the machine, the crystals in the liquid stay in suspension, the TNT does not have time to overheat where it is in contact with the water jackets or form a crust on its surface in the reservoir where it is in contact with the atmosphere. However, the pouring of a truckload at a time has the advantage of not requiring an indexing machine. We only require schedules sufficiently large to justify the construction of such machines before building them.

OPERATING DETAILS OF FIRST-POUR MACHINE

The 155 mm first-pour machine is shown in operation in Fig. 7. As will be noted, no three-way plug cock or vapor condensation are required on this machine. The top of the machine is 5.5 ft above the floor so the operator stands on a removable platform.

The neoprene stoppers used are a stock item and will be found in most chemical laboratories. The stopper valves of the 155 mm first-pour machine are shown in Fig. 8. Sizes varying from No. 4 to No. 7, depending on the size of the measuring-cup nozzle, are used. The six 105 mm top-pour neoprene stoppers were in use 3 months before being replaced. The stoppers are cut to a length of ¾ in., which we find gives the necessary resiliency for long life.

The pressure on the rubber stopper required to balance the head of TNT when it was 1 in. above the top of the measuring cup was about 10 oz per sq in., so a total pressure of 4.5 oz on the stopper, when it was against the ¾-in-diam cup orifice, held the TNT in the cup.

The stopper-type valve when opened must be swung clear of the stream of TNT flowing from the cup and no attempt made to stop the flow by closing the valve, as it will only result in TNT being splashed into the splash pan. The cup should hold only the measured quantity of TNT required and therefore should be allowed to drain completely.

The velocity of the TNT in the throat of the machine during the filling operation should not be less than 9 ips to keep in suspension crystals that have formed or the larger particles of flake TNT that have not had time to melt.

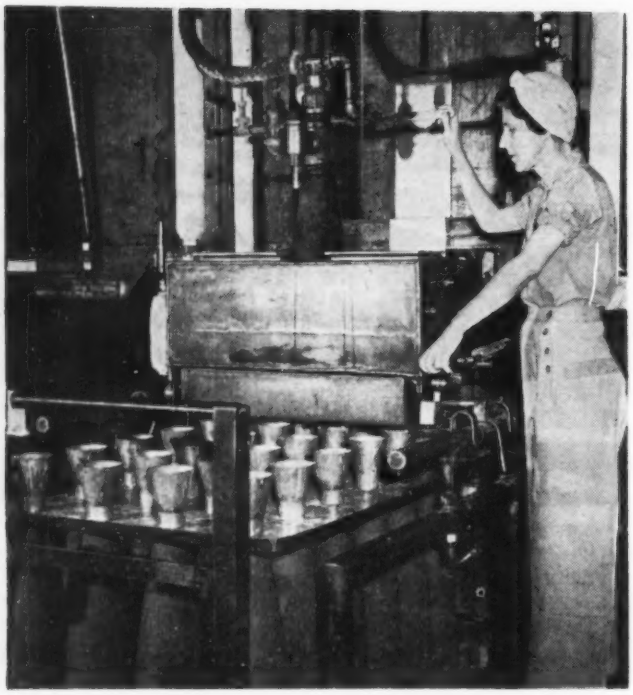


FIG. 9 MAKING THE RISER POUR ON 155 MM SHELLS

The excess TNT that drains back into the reservoir from the measuring chamber after each filling cycle helps in keeping the heavier particles of TNT in suspension and also flushes chunks of TNT off the screen that may have settled on it.

A vacuum of 1 in. of mercury will sustain a column of molten TNT 9.37 in. high at a temperature of 177 F. The distance from 1 in. above the top of the measuring cup to the lowest level at which the TNT could be drawn in the reservoir of this 155 mm first-pour machine was 13 in., so that a vacuum of less than 2 in. of mercury in the measuring chamber caused the TNT to flow rapidly from the reservoir into the measuring chamber and fill the cups, even when the TNT was drawn down to its lowest level in the reservoir.

Since many liquids when heated and subjected to a vacuum will vaporize rapidly as the vacuum is increased, we subjected a small amount of molten TNT in a large test tube, surrounded by a water bath varying from 85 to 90 C, to a vacuum of from 23 to 24 in. of mercury for 1 hr. What little vapor was made was passed through a caustic-soda solution, but only a trace of TNT was found. We expected to get a considerable amount of vapor at that relatively high vacuum because one gets a decided taste and odor of TNT above the surface of a cooling tub; however, our experiments did not bear out our expectations We concluded from this experiment that, since the maximum vacuum required in the measuring chamber was less than one-tenth of that used in the experiment, subjecting the molten TNT to this small vacuum had no appreciable effect on it.

Fig. 9 shows the fifth machine constructed in operation, making the riser pour on 155 mm shells. The operation of this machine is quickly mastered. In Fig. 9, the operator is shown with her right hand opening the air-supply valve to the ejector, during which time she watches, through the glass-covered opening, the measuring chamber and cups fill. After closing the air valve, the operator watches the excess TNT drain back into the reservoir. When it gets below the top of the cup rims, she trips the lever shown in her left hand, which snaps the cup valves open, and the TNT discharges into the shells. To close the cup valves, the operator rotates the lever shown under her left arm in a counterclockwise direction until the trip lever drops into place, thereby locking the rubber stopper valves tight against their seats. The machine which automatically pushes the truck two rows at a time is shown in Fig 10.

The tops of the measuring cups do not have to be at exactly the same level for accurate measuring. Should the machine get out of level, all cups would be equally out of level and the volume of each affected equally.

Experiments were conducted about a year ago to determine how accurately the cups would measure. We placed containers under each one of the nozzles five different times and the machine poured the contents of each cup five times. We obtained a variation of not more than 0.35 per cent for any one cup. Recently, we repeated the experiment with one of the newer eight-cup machines by pouring into shell splits and weighing the casts. The maximum variation from the average weight of the twenty-four casts was 0.36 per cent.

The volume of TNT in the cups can be quickly changed by putting metal disks or balls in them to displace the desired amount of TNT, or, if a larger volume of TNT is required, extension rings are fitted over the tops of the cups, the cup lips being designed for that purpose.

The compressed air for operating the ejector is piped to it from the 90-psi general supply main and is reduced to pressures of from 10 psi to 25 psi, depending on the size of the machine, the required rate of filling, the per cent of feathering, and on how clean the ejector nozzles and screen in the reservoir are kept. Both ejector nozzles are easily removed with the fingers and can be quickly cleaned when necessary.

With the piping arrangement shown in Fig. 3, the compressed air from the supply main, after passing through the reducing valve, blew through the nozzles of the ejector continuously and the three-way plug cock controlled the filling of the cups. The machines are now connected as shown in Fig. 8,

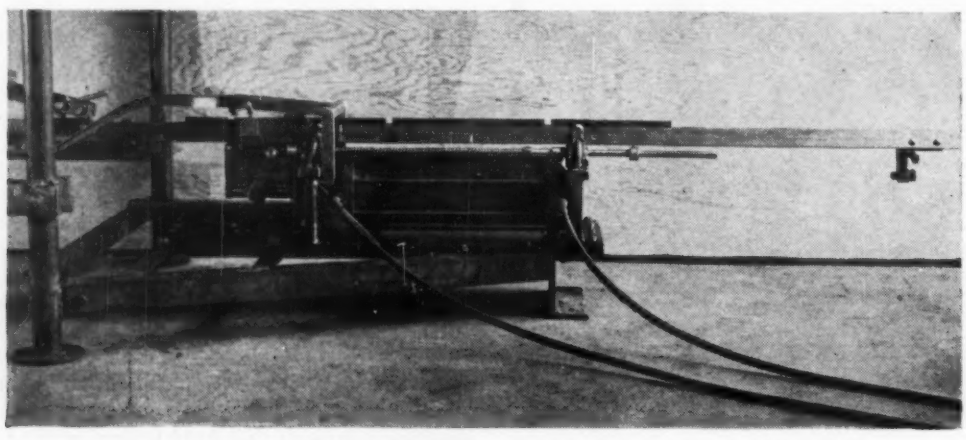


FIG. 10 THIS MACHINE PUSHES TRUCKS TWO ROWS AT A TIME

with the ejector connected directly to the machine, the filling of the cups being done by opening the air-supply valve to the ejector. The vacuum breaker, shown in Fig. 9, has not been found to be necessary.

NECESSITY FOR RISER-POURING OPERATION

The volume of the TNT in the cups is not the volume of the TNT in the shells immediately after pouring, since it requires 10 sec for measuring cups to empty the TNT into the shells which are usually around 100 deg F colder than the TNT being poured into them. The rapidly crystallizing and shrinking TNT around the periphery of the shell starts dropping the level of the TNT in the funnel immediately. The specific gravity of this mixture of frozen and liquid TNT is approximately 1.50, so that more capacity in the cup is required than the volume of the section of the shell being filled. The specific gravity of the TNT in the cup with approximately 8 per cent of feathering is approximately 1.48. The specific gravity of the frozen funnel riser varied from 1.49 and 1.51, and our splits are averaging a little above 1.60.

If the 155 mm machine pours approximately 3 in. up into the funnel, the TNT will shrink below the bottom of the funnel in about 5 min, and the frozen cast will extend up to the bottom of the funnel for a diameter about equal to the inside diameter of the funnel. Pouring up into the funnel by the steady small-diameter stream from the measuring-cup orifice prevents the TNT from splashing up onto the threads, and therefore the threads stay clean. With hand-rubber-bucket pouring, it is necessary to stop for a few seconds when the TNT has reached the bottom of the funnel to allow the TNT surface between the funnel and shell to freeze. If the funnel is filled without doing this, the shell threads will usually become

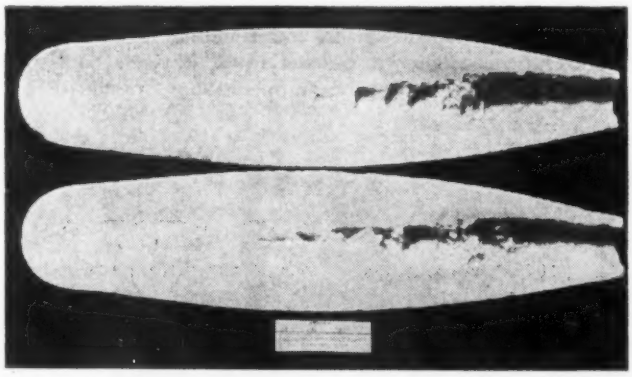


FIG. 11 SECTIONS THROUGH SHELLS SHOWING CAVITY FORMED BY SHRINKING OF TNT AFTER FIRST POUR

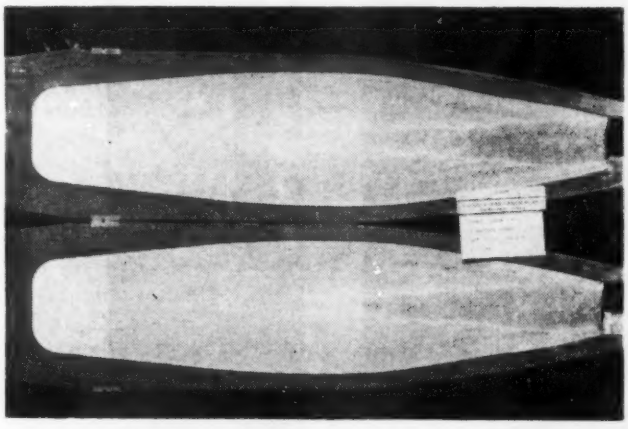


FIG. 12 SECTION THROUGH SHELLS AFTER RISER POUR, SHOWING SOLID LOADING

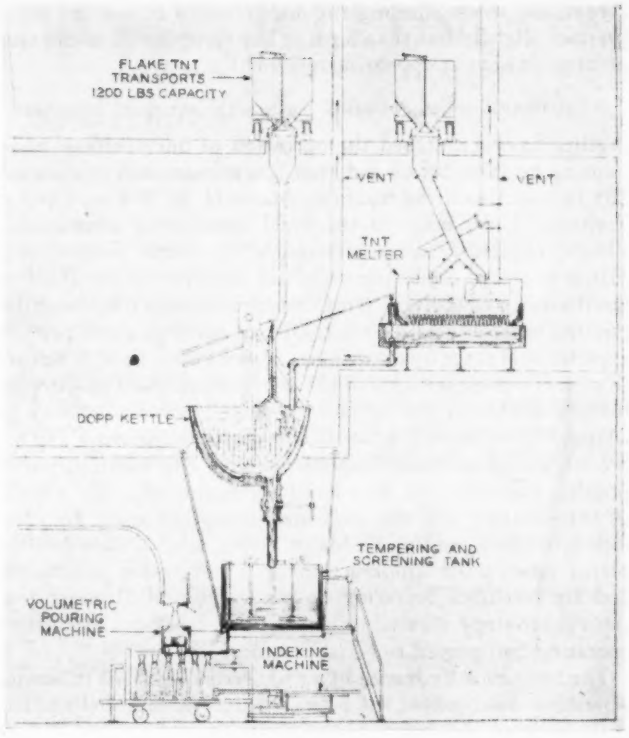


FIG. 13 DIAGRAM SHOWING FLOW OF TNT BY GRAVITY FROM TRANSPORTS TO POURING MACHINE AND INTO SHELLS

partly filled with TNT, and the removal of this TNT is an expensive operation.

In order to fill the cavity shown in Fig. 11, formed by the shrinking of the 14.5 lb of TNT poured into the shell by the first-pour machine, it is necessary to make a second pour up to $^1/_2$ in. of the top of the funnel with the riser-pour machine. As the TNT in the cavity shrinks, sufficient TNT from the funnel riser feeds into the shell so the entire cast of the shell is solid with no cavitation present as is clearly shown by the sectionalized shells in Fig. 12.

Within 20 min after the first pour is made, the solidifying TNT in the shells is probed with a scraping tool which agitates it, preventing the formation of long crystals. One hour later and again two hours later, the TNT in the shells is probed with breakdown knives to keep the cavities being formed opened to the main cavity. Just before the riser pour, the shells are either again probed with breakdown knives or with the steam-heated tubes of the core-melter machine.

The manpower required to handle TNT has been reduced considerably by the use of 1200-lb transports which are brought up to the third floor of the melt-pour buildings, by elevators, which at one time were used to carry ammonium nitrate to preheaters that have been removed.

Fig. 13 shows clearly the flow of the TNT by gravity from the transports to melter, to the Dopp kettle, to the tempering tanks, to the pouring machine and into the shells, and also shows one transport discharging the flake TNT direct to the Dopp kettle for feathering. Dust and vapors are much more easily controlled when this sytem of handling both flake and liquid TNT is used, and very little TNT gets on the floors.

Temperatures taken in the TNT melter reservoir during regular operation vary from 190 F to 187.7 F, depending on how much TNT is melting on the grids. Feathered TNT is kept in the Dopp kettle until crystals show in considerable numbers, at which time the temperature is 177.1 F. The temperature in the tempering tank and pouring-machine reservoir also shows 177.1 F, although the TNT is heavier with crystals than when it is discharged from the Dopp kettle. The average tempera-

ture of the steam entering the melter is 225 F, and the steam pressure slightly less than 5 psi. The Dopp-kettle-outlet temperature is kept at approximately 182 F.

VOLUMETRIC-SHELL-POURING PRINCIPLE WIDELY ADOPTED

After having watched the operation of our antitank mine-pouring machine before and after it was converted to a six-cup 105 mm shell-pouring machine, Major H. N. Pearre, Chief of Technical Unit, office of the Field Director of Ammunition Plants, requested representatives of the other shell-loading plants to attend a meeting on March 21, 1944, at the ILOP to familiarize themselves with multiple-volumetric machine-pouring procedure which the ILOP had developed well past the experimental stage by that time. Major Pearre let it be known that, if the plant layout and the ammunition these plants were loading could, in the opinion of their engineers, readily be adapted to volumetric-pouring, he would recommend the approval of the necessary expenditures for the construction of pouring machines and their auxiliary equipment. As a result of this meeting and the enthusiastic support given to volumetric machine pouring by Major Pearre, several shell-loading plants have under construction or in operation volumetric pouring machines operating on the vacuum-filled measuring-cup rubber-stopper-valve principle, which several months of operation had proved to be satisfactory.

The Sangamon Ordnance Plant has recently placed in service a pouring machine which pours all sixty 90 mm shells in the push truck at one time. Inasmuch as the melt-pour building has only one floor and the drain-off from the melter is too low to allow the use of a Dopp kettle or tempering tank, Sangamon has placed its reservoir on the floor and connected it to the measuring chamber with a jacketed pipe. The level of the TNT in the reservoir, when it is nearly empty, is approximately 30 in. below the tops of the sixty measuring cups. This requires approximately 4.5 in. of mercury vacuum to draw the TNT into the measuring chamber at the desired rare. This lift, plus the several feet of jacketed pipe which connects the reservoir with the measuring chamber, makes the filling, leveling-off, pouring, and valve-closing cycle for this machine approximately 1.75 min. Since 60 pours are made at one time, this machine should take care of loading over 1,000,000 shells per month.

Fig. 14 shows 60 streams of TNT running out of the measuring cups into the 90 mm shells. The valve mechanism is operated by the pneumatic cylinder shown at the back and the air pressure is set to hold the 60 rubber stoppers against their seats with a pressure of 5 lb each.

About five months ago, the Ravenna Ordnance Plant constructed a volumetric pouring machine. It is a single-row ten-cup unit. Inasmuch as monorail carriers holding sixty 75 mm shells are used instead of push trucks, it was necessary to push the monorail carrier under the pouring machine by having a movable section of monorail. The valve mechanism for opening and closing the ten rubber stopper valves was operated with a pneumatic cylinder. Tests made on the machine showed that the trays of 60 shells could be positioned and filled in approximately 3 min or 150 trays (9000 shells) could be loaded per shift. However, owing to schedule changes, this machine was never used in production. At the present time the Ravenna Ordnance Plant has built and installed a second machine which will pour twenty-eight 155 mm shells at one time. The machine was being given trial tests at the time our last information was received.

Inasmuch as the Chief of Ordnance has made volumetric-multiple-pour machine loading the standard method of shell filling, it is probable that all shell-loading plants will soon have machines in use. The Wolf Creek, Pantex, and Louisiana Ordnance Plants have built machines of this general type for shell, mine, and small-bomb loading but photographs and operating data are not, as yet, available.

[Since this article was written in January, 1945, the Sangamon Ordnance Plant has placed four machines in service; Wolf Creek Ordnance Plant, three, and Iowa, Ravenna, and some other plants have one or more in operation.—EDITOR.]

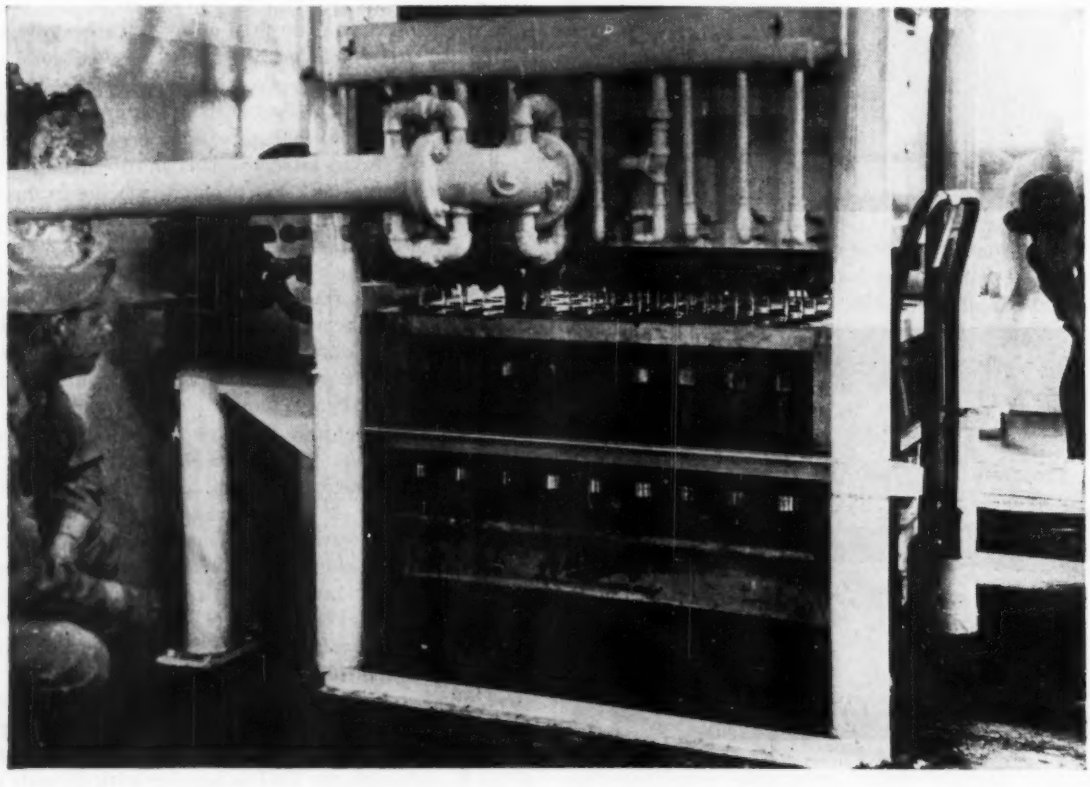


FIG. 14 ONE OF FOUR MACHINES AT SANGAMON ORDNANCE PLANT

ON ENGINEERING WRITING

By DONALD M. CRAWFORD

SECRETARY OF THE J. G. WHITE ENGINEERING CORPORATION, NEW YORK, N. Y.

ON December 10, 1944, the *New York Times* "Book Review" carried a sad commentary on the writing ability of the engineering profession. Referring to the vast number of technical instruction manuals that the Bell Telephone Laboratories has been required to publish recently for the Army and Navy users of its equipment, the *Times* said:

"The company has discovered that it is easier to hire a qualified editor and teach him what he needs to know about the technical terms involved than it would be to take a qualified engineer and teach him what he would need to know about the art of editing and the preparation of manuscript for the printer."

The truth of the premise has long been recognized by the leaders of the engineering profession, namely, that American engineers as a group are deficient in the command of their mother tongue, both spoken and written, and certain of them have long campaigned for greater attention to English in the engineering curriculum. In his commencement address at the Massachusetts Institute of Technology in 1937, Gano Dunn defined engineering as "the art of economic application of science to social purposes" and emphasized the need of the engineer to be able to make his views prevail in society, to persuade and to contend.

However, few practicing engineers have the time or opportunity to avail themselves of formal instruction to develop their writing ability. Improvements can be brought about by the individual if he is aware of his deficiency and if he is willing to correct it. The following notes have been made to assist him in recognizing some weaknesses that are commonly found in manuscripts prepared by engineers:

1 *Have a worth-while subject and something to write.*

Most engineers know what they want to write. Their subjects are usually well defined and the material is generally factual, not entailing the plot requirements that so frequently confound fiction writers. However, in a well-written article, the thoughts flow logically and smoothly from point to point just as the words themselves flow in smooth order through successive sentences and paragraphs.

2 *State your purpose first and end with a conclusion.*

Most of your readers will be busy people and you must compete for their interest against other writings, many of which may be more interesting than yours. Tell your reader, if possible in the first paragraph, what "it is all about," much as your favorite newspaper does in opening its articles, so that he will not be in doubt as to whether or not he wants to read your presentation. If your initial statement of purpose interests your reader, he will probably read it to the end to discover your conclusions.

The concluding paragraph or sentence should refer in some way to the introduction in order to round out the topic and leave the reader with the impression that you have done or proved what you said you would.

The old darky preacher had the right idea when he said about his sermons, "Fust, Ah tells 'em what Ah'se gwine to tell 'em. Then Ah tells 'em, and then Ah tells 'em what Ah told 'em."

3 *Define your terms clearly and avoid ambiguity in their use.*

This is most important unless you are dealing only with terms that will be readily recognized by all your readers and do not have multiple meanings, such as kilowatt-hours and pounds per square inch. The words "plant" and "unit" are often used ambiguously by engineers as meaning the whole as well as some of its parts and should therefore be used only with care.

Examples of such faulty usage are as follows:

"In the East St. Louis *plant*, there is a high-octane gasoline *plant* and a dewaxing *plant*. The crude oil is heated in a large *heater unit*, piped to a cracking *unit* consisting of several Dubbs *units*.

"*Unit* No. 1 in the Delray plant consists of a turbine *unit* and a boiler *unit*. Boiler water is prepared in a treating *unit*, and the control room is heated by *unit heaters*."

Subsequent reference to either *plant* or *unit* alone would be ambiguous.

4 *Use correct grammar.*

The rules of grammar are legion but some of the most common violations by engineers may be avoided by observing the following cautions:

(*a*) Be consistent with tenses.

If your narrative begins, for example, with the past tense of verbs, don't change in the middle to the present tense or vice versa. If statistics for 1940, "show" something, don't switch later to "they showed."

(*b*) Don't mix singular and plural forms.

A singular subject takes a singular verb and a plural subject a plural verb, but many writers are tripped by this simple rule. For example:

"It don't prove" is never correct, because it is a contraction of "It do not prove."

(*c*) Antecedents for pronouns should be unambiguous and not too remote from their modifying pronouns.

"This," "that," or "its" should only be used in such a way that there can be no doubt as to which word is its antecedent. This becomes more difficult when the antecedent is separated from its pronoun by more than one sentence or is in a different paragraph. Note the ambiguity in the meaning of "its" in the following sentence:

"The discussion included the Power Company's principal generating station and *its* interconnections, *its* billing methods, and *its* labor relations."

Also, "*this* puts *that* in the best position."

However, the repeated careful use of pronouns, when there is no possibility of misunderstanding their antecedents, may serve as a valuable cohering force in connecting the thoughts

(*d*) Try to avoid split infinitives.

A split infinitive results from placing one or more words, generally adverbs, between "to" and the verb that completes the simple infinitive, such as "to quickly recover." This practice, which frequently produces acrimonious debates among writers, is generally discouraged but it is not always wrong. Sometimes a split infinitive is preferable to a word arrangement that suggests stiffness, or permits vagueness or ambiguity; for example:

"He was assigned to *personally* direct and supervise the erection of the cat-cracker."

This emphasizes the important word "personally" better than

"He was assigned personally to direct and supervise the erection of the cat-cracker." (Stiff and awkward.)

Or the following:

"He was assigned to direct and supervise the erection of the cat-cracker personally." (Sacrifices emphasis.)

However, don't confuse a split infinitive with the insertion of adverbs or other words between the various auxiliaries or parts of a compound verb. The latter is good practice and frequently determines the emphasis of the sentence. For example:

"To be *completely* understood"
"To have *readily* been observed"
"Are *also* being given"
"Have *only* been developed"
"He came nearest to *really* solving the problem"
"Values have *rather steadily* declined"
"Should *certainly* maintain its position"

are *not* split infinitives.

(*e*) Place modifying words or phrases as close as possible to the words they modify or emphasize.

To do so makes it easier to grasp the thought and avoids ambiguous or stiff and awkward expressions.

"Is the best surface measure of temperature"

should be

"Is the best measure of surface temperature"

since "surface temperature" is the thing to be measured.

The position of modifiers frequently controls the emphasis and meaning, as illustrated in the preceding paragraph, and hence they should be carefully placed. Note the differences in emphasis and meaning in the following:

"*Only* he cleaned the condenser tubes."
"He *only* cleaned the condenser tubes."
"He cleaned *only* the condenser tubes."

(*f*) Avoid final prepositions.

A preposition at the end of a sentence is not necessarily incorrect. In fact, one is sometimes effective, but more often a final preposition is superfluous or awkward, as illustrated by the sentences:

"A preposition is not a good word to end a sentence with."
"What do you want a book to read out of from for?"

(*g*) Use words correctly.

Certain words which are similar in form have come by usage to have special meanings which are sometimes confused:

"Economic"—pertaining to man's living.
"Economical"—pertaining to thrift or economy.
"Periodic"—pertaining to a period of time or cycle.
"Periodical"—pertaining to a publication issued at intervals.

Incorrect words, of course, should always be omitted, such as "irregardless" (a bastard word—erroneous attempt to say "regardless" or "irrespective").

5 *Try to write in an attractive style.*

Wholly apart from grammar and without violating any of its rules, an article or paper may be dull, monotonous, and uninteresting if careful attention is not paid to the manner in which the sentences are put together.

Some engineers never try to write anything more than a series of simple declaratory sentences. These can be just as dull to mature minds as a series of kindergarten sentences, such as: "The dog saw the cat. The dog ran after the cat."

The choice of style will depend on the interests of the intended audience, but no engineering reader enjoys repetition, monotony, redundancy, verbosity, or an obviously incorrect statement or expression.

(*a*) Be natural.

Try to use language with which you are familiar. Avoid expressions that are pedantic, ponderous, or colloquial.

(*b*) Avoid monotony.

"The" at the beginning of two successive sentences is generally enough. Don't use three initial "the's" except for deliberate emphasis. Find some other way to start the sentence, as by shifting a phrase expressing time to the beginning, in order to avoid that cause of monotony.

(*c*) Be brief; omit unnecessary words.

Brevity saves time for the reader and aids coherence. Long sentences and long paragraphs, though sometimes desirable, create a slow tempo and are not conducive to quick comprehension of the ideas you wish to convey. However, even short simple sentences can become monotonous and no one style should be overworked.

Quite frequently, some words or phrases can be omitted without any loss of effect or meaning, for example:

"Very"
"It should be noted that."
"Obviously" (this might be construed as an insult to your reader's intelligence.)

(*d*) Avoid repetition.

Find synonyms when you are tempted to use the same word more than once, particularly in the same or near-by sentences. If you wish to call attention to the results of some "figures," refer to them variously as "statistics," "calculations," "computations," and what they "show," "indicate," "demonstrate;" but preferably vary the form of the conclusions, too.

Don't say the same thing twice unless you are summing up as in a conclusion. If necessary to repeat the thought for emphasis, state it in different words, unless you would rather gain in clarity what you lose in attractiveness.

Avoid redundance or unnecessary repetition of words or phrases having similar meaning; such as the following:

"Co-operate *together*"
"*Potential* possibilities"
"The *very* identical thing *itself*."

(*e*) Make clear statements; avoid ambiguity.

Wherever a choice exists, use words of specific rather than general meaning, in order to prevent doubt in your reader's mind as to what you wish to convey.

(*f*) Avoid parenthetic expressions.

A number of parenthetic expressions or clauses in apposition are undesirable. They are only momentary distractions, they are frequently annoying, and they interrupt the smooth flow of thought toward the desired conclusion. The sentences should be broken up and rearranged without too many thoughts in a single sentence.

In his essay, "The Awful German Language," Mark Twain illustrates from classic German literature how annoying this form of expression may be when carried over into English. It reminds him of the dentist who secures your instant interest in a tooth by gripping it with his forceps, and then drawls through a tedious anecdote before giving the dreaded jerk. "Parentheses in literature and dentistry are in bad taste."

(*g*) Get the main verb in early.

The German language has a way of stringing out clauses and phrases and making the reader wait for the last few words

of a sentence to find the principal verb. Though perfectly good German, such expressions are awkward in English. The verb should appear early in the sentence, leaving the object of the sentence for the climax. For example:

"As a highly desirable procedure supplementary to the use of existing records, whether prepared by governmental or other agencies, aerial photography to determine the conditions on the site *was used*."

Here the entire principal clause with the subject and verb in normal order should have been advanced, but there are too many subordinate thoughts. Instead, it might be written with an additional verb, as follows:

"Aerial photography *has become* a highly desirable procedure supplementing existing records, whether made by governmental or other agencies, and *was used* at Cheyenne to determine the conditions on the site."

(*h*) Be logically consistent.

Use connecting words and phrases to afford smooth transition from one thought to another and to keep up the interest. In opening sentences or paragraphs with new thoughts, connecting words such as "furthermore," "notwithstanding," "in addition to," "despite," "another," and phrases relating to that which came before or follows, help to avoid jerky narrative or argument and aid in coherence.

(*i*) Use balanced or parallel construction

Clarity and quick understanding are aided by balancing similar parts of a sentence. Sentences should be rearranged if the arrangement is such as to cause a reader to reread in order to determine the meaning; for example;

"The natural-gas situation from the economic viewpoint with respect to the number of wells seems to be that the maximum already has been reached and with output diminishing steadily."

might better be rewritten to read

"From the economic viewpoint, it appears that the maximum number of natural-gas wells has already been reached and that their output has steadily been diminishing."

6 *Distinguish fact from opinion.*

Engineering facts are generally recognizable but the conclusions to be derived from them are often debatable. Hence it is important to make clear the line of demarcation between the uncontested facts and your opinions.

7 *Use tabulation and indentation where clarity or legibility may be improved.*

Engineering articles frequently lend themselves to outline form, point after point, and the numbering of paragraphs or sections is sometimes desirable. It is certainly preferable when describing or enumerating a list of items, to write them in tabular form, rather than to string them out in sentence or paragraph form. Likewise, the use of indentation by varying the width of margins serves to call attention to quotations, topic headings, or variations in emphasis.

How much clearer it would be to tabulate and rearrange the following properties of modern lubricants instead of running them together in one sentence:

"Modern lubricants must have high film strength, high resistence to oxidation, not form sludge in the engine, no bearing corrosion, have a low oil consumption in the engine, low pour test (wax-free), high viscosity index, and low increase in viscosity during use."

8 *Be careful of punctuation.*

Some of the rules of punctuation are just as absolute and unvariable as the rules of grammar. However, there are many instances where the use of punctuation is optional, particularly in open style which is direct and relatively simple. Most engineering writers are naturally inclined to a direct and informal style of writing and "open punctuation" is natural for them. The modern trend is a practical one. All punctuation which is not essential is omitted unless it aids in understanding or reading the sentence, as in indicating the end of a subordinate thought, or a place where a reader would drop his voice and pause if reading aloud.

Innocent appearing little commas can change the meaning of a phrase, if omitted, as for example:

"There was a severe shortage of structural steel, lumber and building materials, rayon materials and machinery and other accessories."

Does "machinery" mean "rayon machinery?" If so, a comma should follow "machinery;" otherwise the sense is entirely different.

Abbreviations, if used, should conform to engineering standards, such as the "American Standard Abbreviations for Scientific and Engineering Terms."

9 *Use illustrations where possible.*

Photographs or other graphic aids such as charts or diagrams are fundamentally interesting and should be included where possible. They improve the appearance of the printed page by breaking the monotony of solid text. Most engineering articles are based on something which can be represented by picture or diagram, and one or more such illustrations should be regarded as indispensable to an article.

Charts or drawings should be drawn in such a way as to be readily understood. A clear title should appear on the chart or in the caption, and calibration units should be clearly identified. Lettering should be large and clear enough to be read from a reasonable distance.

If a number of lines or areas on the drawing are to be distinguished, careful attention should be given to the possibility and probable method of reproduction. Although the use of varied colors appeals to the eye, it is practical only on the original in most cases, as engineering articles are seldom reproduced by color process. On the other hand if reproduction is likely, it will probably be in black and white, in which case chart lines must be identified by symbols, and areas distinguished by various forms of crosshatching or Ben Day effect. This is doubly important if the chart may possibly be projected onto a screen or photostated. Lines must be bold and heavy enough to stand out and yet not close enough to run together in reproduction.

The subject of engineering writing and hints to engineers who wish to express themselves on paper presents many facets. However, engineers are not immune to the same requirements for quality of style that confront writers in other fields. These may be summarized as:

Unity—having as far as possible a single subject for every sentence, paragraph, or chapter.

Mass—distributing the mass of material over the various parts of the article in proportion to the emphasis which each should receive.

Coherence—tying the various thoughts together by overreaching pronouns, references from one paragraph to another, and indications to the reader that he should carry in his mind what he has read.

Before the war, a number of the larger companies and professional societies offered courses in engineering report writing to their employees or members in order to supplement their more formal training. These courses were extremely useful, stimulating, and generally well attended. It is hoped that the courses will be restored and that engineering curricula will be strengthened in this direction, so that eventually the average engineer may be able to express himself more creditably in writing. Engineering writing, which is the only way an engineer can tell his public what he is doing, is something to take care of, and it needs care now.

MANAGEMENT RIGHTS *and* COLLECTIVE BARGAINING[1]

By DOUGLAS McGREGOR

INDUSTRIAL RELATIONS SECTION, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE literature of industrial relations contains a number of more or less encyclopedic analyses of the content of collective-bargaining agreements. These are useful if a person wishes to find examples of representative clauses under a particular heading. Until recently there have been few attempts to consider the union agreement from a functional point of view. This book[2] fills a real need because it attempts to do exactly that. In terms of a fairly broad systematic framework, the authors have examined the chief functions of a union agreement and have considered ways in which agreements fulfill or fail to fulfill these functions. Consequently, although the book is less useful than a handbook to those who want to look up a particular type of clause, it is far more useful to those who are interested in the union agreement as a whole. Even the member of management who is experienced in labor negotiations will find this book worth reading, while the inexperienced person may well discover that it is a gold mine.

The approach of the authors is eminently practical. They consider that a union contract has three major functions: (1) to protect the union, (2) to protect management, and (3) to protect the individual employee. Each of these functions is considered in detail, and a fairly wide selection of possible types of clauses is presented. More importantly, however, there is a shrewd analysis of the possible pitfalls in negotiating with respect to these functions. The authors are extremely alert in pointing out places in which management, through failing to think the problem through carefully enough, has negotiated a clause which has had unfortunate repercussions during the administration of the contract.

The final portion of the book is devoted to a helpful discussion of the actual process of negotiation and the process of presenting a case before the National War Labor Board. Their own experience in both of these phases of collective bargaining has given them a good insight. Although the book is frankly written for management, there is little doubt that the union negotiator will find much of value in it. There is likewise little doubt that it will make him mad.

In spite of the definite positive values just mentioned, there is in this reviewer's opinion a fundamental defect in this book. It consists in a shortsightedness with respect to the problem of "rights," and it manifests itself throughout the whole book in a somewhat rigid overemphasis on the importance of management's rights. Of course since the book is written for management, one should expect an emphasis on the things that management desires to obtain or to defend in negotiating a contract. The trouble is that the course of action and the point of view recommended by the authors are more than likely to have results which are the exact opposite of the expected ones.

The authors start off realistically enough by pointing out carefully that management has no divine right to manage and that "management thinking as well as management argument is likely to be sounder when management regards itself as being required to exercise certain functions in order to fulfill its responsibilities, rather than considers itself as being vested with inalienable prerogative."[3] But the authors themselves immediately forget this brave beginning. The word "rights" appears on almost every page of the section devoted to management protective clauses. It is revealing that in the following section devoted to employees' protective clauses, the discussion centers around employee *wants!* One cannot help but feel on the basis of the authors' presentation that management does have fundamental important inalienable rights whereas the worker merely has wants.

To be sure there is some reference to employee rights. However, careful examination leads one to conclude that the word is a euphemism applied as the authors apply it. For example, the employee's "right to work without being forced to join or remain a member of a union" receives considerable attention. It is clear, however, that this right to work does not mean "the right to have a job." In fact, the authors stress elsewhere the fact that management must have the right to employ whom they wish. To the employee, the right to work (or any other right) means nothing if someone else decides whether he may exercise it. The authors are concerned to show how union security clauses may interfere with this "right." However, it makes very little difference whether the someone else who decides whether you may exercise a right is a union or a management!

If we back off just a little from the heat of the battle around the bargaining table, it is apparent that members of management, like other human beings, are striving to satisfy their wants. In order to do so, they must be able to direct the activities of people *who will agree to have their activities directed*. Not only would management have no rights, but it would literally cease to exist if this agreement could not be obtained. Management is therefore fundamentally just as dependent upon its employees as they are upon it. Management controls "means" (principally money) for the satisfaction of workers' wants. But workers control "means" (their labor) which are indispensable to the satisfaction of management's wants.

In such a relationship it is not only unrealistic but dangerous to insist upon the rights of one party. To do so invites attack. The authors point out that management has a responsibility to exercise its rights with due consideration for the wants of its employees. This point should and could be made a good deal more bluntly. The fact is that management cannot continue to satisfy its wants unless it gives consideration to the wants of its employees. Failure to recognize this fact has been responsible for the considerable curtailment which has already taken place in what were once supposed to be the irreducible rights of management. There are no signs today that this process of curtailment of management's rights is slowing down. If members of management follow the course outlined for them by Messrs. Hill and Hook the possibility is that the process of curtailment will be speeded up in the future.

To reiterate, as the authors do on nearly every page of this otherwise helpful book, that management must protect its

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

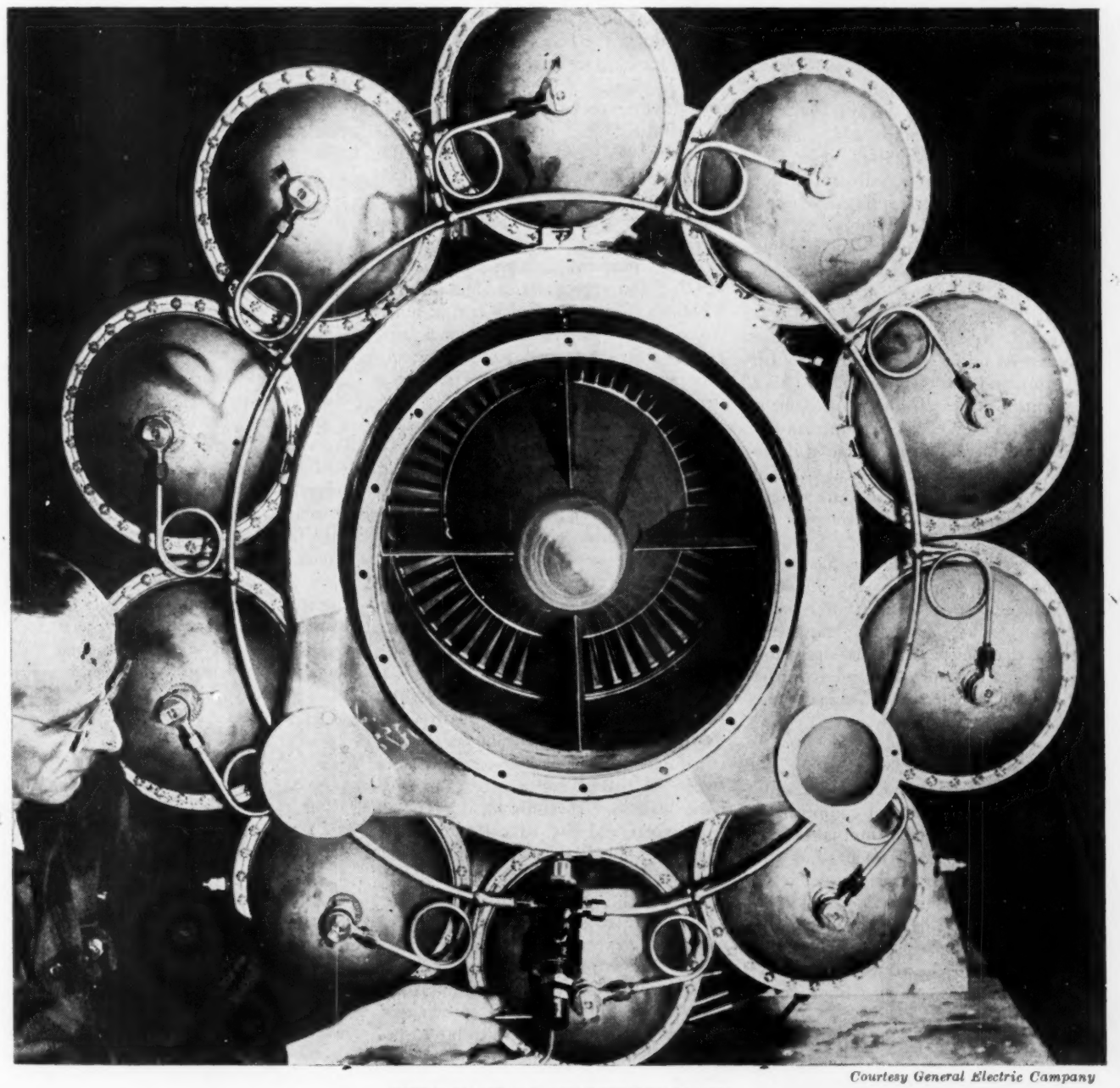
[2] "Management at the Bargaining Table," L. H. Hill and C. R. Hook, McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1945. 300 pps.

[3] Page 58, Hill and Hook.[2]

rights in order to exist is to encourage management to act in such a way as to destroy itself. We might just as well face it squarely that, except in a formal and legalistic sense, *management has no rights*. Neither have unions. To the extent that either managements or unions behave as though they had them—to the extent that they depend on their imaginary rights to maintain their respective positions—they are setting in motion the very forces which will curtail their freedom to act and will prevent the satisfaction of their wants.

If it is possible, as this book clearly demonstrates, to talk intelligently about the employees' wants in relation to collective bargaining, it is equally possible to consider this problem from the point of view of management's wants. Only when management begins to view collective bargaining in those terms will it have begun to face reality. The reader would find it an illuminating experience to substitute the word "want" (or "need") every time he encounters the word "right."

This point is a subtle one, but it is most fundamental to the whole process of collective bargaining. There is no denying the fact that management cannot exist unless it can perform certain functions. But there is no indication from history or from present circumstances that management will be permitted to perform these functions merely by insisting on its rights. It is equally true that the worker must be permitted to perform certain functions in order to live. Unless he can work and obtain the means of livelihood from his work, he too will cease to exist. The effective way to meet these inescapable facts is not to encourage a collision between the immovable object and the immutable force, but to shift the frame of reference. This shift can be brought about when management approaches the bargaining table with a realization that like the union and the employee it must find ways through negotiation to satisfy its wants. To do otherwise is to face the inexorable march of events while protesting plaintively that "this cannot happen."



Courtesy General Electric Company

POWER PLANT FOR JET-PROPELLED PLANES

(In this illustration the jet exhaust cone has been removed from a G-E jet engine to expose the blades of the gas turbine that drives the unit. This turbine, said to revolve at 10,000 rpm with gases at 15000 F is connected to an impeller-compressor at the front of the engine forming a single rotary part. Around the casing can be seen the ten combustion chambers in which the fuel, kerosene, burns in compressed air.)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Armed Forces and Engineering Colleges Should Continue to Co-Operate

TO THE EDITOR:

The record of achievements of our engineering colleges both in training and in research for the Army and Navy during World War II is one of which we in the colleges may be justly proud.

Large numbers of civilian and military personnel have been trained on the campuses, in Army camps, and in industrial centers. The regular engineering curricula, the Army Specialized Training Programs, the Navy Training Programs, and five years of the Engineering, Science, and Management War Training programs have all been utilized to furnish vitally needed technical personnel.

Important research developments have been carried on by direct contracts with the Army and Navy, through the Office of Scientific Research and Development and through the Office of Production Research and Development. The colleges have demonstrated the practical value of utilizing their staffs and laboratory facilities for conducting important war research.

The foregoing achievements have been brought out to show that the engineering colleges and the Armed Forces have co-operated wholeheartedly. However, I believe that our peacetime co-operation may be greatly improved, and it is the purpose of this letter to suggest one plan which might do this.

THE PLAN

For the sake of brevity, I am only going to suggest a plan of co-operation which might result to the mutual benefit of the Ordnance Department and the mechanical-engineering departments of the colleges. It will be apparent that similar plans could be drawn up for the Air Corps, Signal Corps, the Navy, and other branches of the armed services together with other college engineering departments.

An examination of the officer and civilian personnel of the Ordnance Department will reveal that a substantial number are engineering-college graduates. It seems reasonable to suppose that the colleges will continue to supply in the future the bulk of the personnel who must have specialized technical knowledge. If this is true, then the Ordnance Department has a real interest in working with the colleges to help them supply the best possible men.

Lieutenant General Levin H. Campbell, Jr., Chief of Ordnance, in his address before the 1944 Annual Meeting of the A.S.M.E.,[1] made a plea for the continued co-operation of the technical societies and the universities in the matter of ordnance research and development Apparently the Ordnance Department has already taken cognizance of the expected peacetime slump in Ordnance development appropriations and interest. I believe that the colleges can do much to keep alive interest in Ordnance matters and at the same time effectively serve the production industries, both at a very modest cost.

I would suggest two major things for the Ordnance Department to do and two things for the colleges to do. First, Ordnance should select from surplus stocks proper laboratory equipment, tools, inspecting and testing gages, instruments, and supplies, and establish these in laboratories at the colleges.

These laboratories would be used for training, for research, and for conducting educational clinics for the industries in the vicinity. Secondly, an officer should be detailed to the R.O.T.C. unit (this has been done in some instances) where these exist to act as liaison officer between the college and industries in Ordnance matters. He could act as a production expert and part-time lecturer. He could make available research problems of interest to Ordnance and possibly direct research through Ordnance fellowships and through co-operation with the engineering experiment stations.

The "know how" of ordnance production might be kept alive and improved upon by establishing pilot production lines in the laboratories. Such pilot lines which had been established in the arsenals proved of great value to industry. They can be used effectively in the presentation of manufacturing-processes courses in the engineering curricula.

The colleges should provide suitable housing for the Ordnance laboratories and co-operate in furnishing undergraduate and graduate students. The study of modern production methods and the conduct of research in fields of importance to Ordnance development would seem to be proper.

A little reflection will show that the production of Ordnance items, for the most part, does not differ in any way from the production of articles and equipment for civilian use in peacetime. Furthermore, Ordnance research and development has in the past greatly contributed to basic scientific knowledge. There is every reason to expect that this will continue to be true.

AUTHORITY ALREADY EXISTS

No new legislation is required to carry out the type of co-operation contemplated here. The Secretary of War under Acts of 1928 and 1936 has the authority to donate equipment to properly qualified schools. The Ordnance Department has placed some equipment in the colleges on loan in the past. This equipment problem is stressed because I am convinced after visiting about one half of the accredited engineering colleges in this country, that very few have either the facilities or the staff to conduct really modern instruction and research in the fields discussed here.

DISCUSSION INVITED

The plan suggested here has gradually evolved as a result of discussions with members of the Ordnance Department since the 1944 Spring Meeting of the A.S.M.E. in Birmingham. If there is any real merit in this suggestion, considerable credit should be given to Ordnance personnel for their interest and encouragement. Alternate plans, improvements on this plan, or other discussion of the basic idea of the colleges co-operating more effectively with the Armed Forces in peacetime can lead to increased national security in the future. Such discussion is invited.

N. C. EBAUGH.[2]

[1] "The Contribution to Ordnance Research and Development by Technical Associations," by Major General Levin H. Campbell, Jr. MECHANICAL ENGINEERING, vol. 67, no. 1, January 1945, pp. 23–24.

[2] Head, Mechanical Engineering Department, University of Florida, Gainesville, Fla. Mem. A.S.M.E.

More Mud in the Water

TO THE EDITOR:

Every so often somebody succeeds in taking the joy out of the draftsman's life by suggesting a new way to complicate his drawings.

A leaf from the engineering data book of a large manufacturing concern has been lying on my desk for several months now, and it is time something is said about it. It relates to surface finish, and it is impressively illustrated with radicals surrounded by a bewildering array of crosses, letters, and mathematical signs. At the top of the page appear the words: "Tentative Standards." Had it not been for that word "tentative" I should have tossed the paper into the wastebasket long ago, but that one word carries a ray of hope. Maybe it is not too late to register a protest against the adoption of any such symbols.

The subject of surface finish awakens in me recollections of long ago. Twenty-five years ago I sat in a conference with the chief engineer of our company and the general foreman of the machine shop to settle this problem once and for all. It seemed like such a simple matter at the time. We expected to get out some sample blocks, say, five or six, finished in differing degrees of roughness. One set was to be held in the drafting room so that the designers could select the finish desired, and other sets were to be placed in the shop so that the machinists would have no difficulty producing what was required. Each block was to bear a number, and the draftsmen were to be instructed to discontinue the old familiar *f* and in its place use a triangle or a V with its vertex touching the line of finish. Inside the symbol was to appear the number of the finish desired.

Satisfied with this simple device, we turned over to the foreman the task of making a set of samples. The latter, being a practical man, asked a few disconcerting questions such as: "Shall I make the samples of cast iron or of steel?" and, "How about brass?" but he finally accepted the assignment without too much protest.

To insure uniformity in the standards we further suggested that the sample pieces be made in long bars which could then be cut into a number of shorter pieces. I can see now that this final admonition bore in itself a lurking doubt as to the practicability of the scheme.

Fortunately, we knew nothing then of microinches or electronics, and we frankly left a few things to the judgment of the inspectors.

Well, the machinist never submitted his sample finishes, and I often wonder how many other companies have gone through the same procedure and ended up at the same place.

What we were really trying to do was to set up some standards which would make it unnecessary for the workmen and inspectors to exercise any judgment of their own. That is what the author of the "Tentative Standards" was trying to do when he worked out his elaborate system of symbols and tolerances. A lot of otherwise smart people think that this can be done, but instead of simplifying the problem they are making it vastly more difficult and complex.

The page on my desk even defines "roughness." It says it is "that deviation from nominal surface evidenced by minute contiguous irregularities on the nominal surface."

Maybe such a definition could be defended in the courts, but it wouldn't be of much help to the poor workman who never got beyond the fourth grade at school. But one thing is revealed by this frantic attempt at elucidation, it shows how deep the problem can become when followed up.

Even the microscope does not disclose all there is to surface finish. Many factors are present which are not readily measured. Material, hardness, uniformity, resistance to rust, porosity, color, appearance, feel, and power to reflect light; all are involved in this complex subject. As to setting tolerances on three-dimensional microstructures—well, let's not get any deeper into that. This is a job for the research laboratory and it would certainly be absurd to carry such matters into the shop at the present stage of our development.

The little conference that I mentioned at the outset was not without its benefits, however; we did take one step forward. We adopted the symbol *g* for ground surfaces, which many others were already using. By employing this mark we indicated the *method* to be followed and in that way established a certain standard that the workmen recognized.

It seems to me, since every method of finishing carries with it definite ideas of accuracy, that instead of adopting new and fearful symbols to tack on our blueprints, we should allow the routing slips to bear their share of the burden.

If, for example, a piece is routed to the milling machines, we would not expect the surface to exhibit the long parallel ridges which it might have if roughed out on a shaper. If a shaft is routed to a wet grinder for a final operation, that in itself indicates the type of finish required.

Above all, why can't every workman know something about the piece he is working on? Even the most automatic of machinists has to be told what to do, surely it shouldn't take much longer to explain why to him.

As to the War Department contracts that are the occasion for the present agitation, let us hope that we are near the end of them. If the millennium is as near as the optimists dream, perhaps it will never again be necessary to mobilize all the factories of the nation under one head and universal interchangeability will then be of less importance.

In the meantime let us keep our blueprints as simple and clear as possible. It would even be a good plan to start revising some of the old ones that we have been using for years, in order to make them more intelligible to the flood of new workmen that is bound to pour into our factories after the demobilization of the armies.

A. L. PASCHALL.[3]

[3] Troy, Ohio. Mem. A.S.M.E.

Engineering Materials

COMMENT BY N. F. HINDLE[4]

The writer wishes to extend to the author his sincere congratulations on this paper[5] detailing recent developments in engineering materials. He recognizes this piece of work as a monumental one, which has required a great deal of research, and particularly knowledge of where to obtain engineering information.

Obviously, in a work of this sort, in spite of meticulous care, some omissions will occur. Since the paper covers engineering materials developments during the last 10 years, the writer would call to his attention an omission in his coverage of the malleable-iron field. Probably the greatest development in that period has been the perfecting of several new types of malleable irons, all of which are classified under the generic term of pearlitic malleable iron.

These engineering materials differ from the regular variety of malleable iron metallurgically, in that they have a pearlitic matrix, whereas in the regular grade, the matrix is ferritic.

That they are recognized engineering materials is evidenced by the fact that the American Society for Testing Materials

[4] Director, Technical Development Program, American Foundrymen's Association, Chicago, Ill.

[5] "Some Recent Developments in Engineering Materials," by Archibald Black, MECHANICAL ENGINEERING, February to May, 1945, issues, inclusive, installments appearing on pp. 101–108; 190–198; 267–274; 334–343, in the respective issues.

recently has promulgated a specification covering mechanical properties, and that another specification has been placed in effect by the Army Ordnance Department. Specifications for the ferritic-matrix malleable-iron castings, as promoted by A.S.T.M., require the following minimum mechanical-property values:

53,000 psi tensile strength
35,000 psi yield point
18 per cent elongation

This class of malleable iron is known as Grade 35018.

By comparison, U. S. Army Ordnance Department specification for pearlitic malleable iron calls for, in general, five possible grades with the following minimum mechanical properties:

Grade E

60,000 minimum psi tensile strength
43,000 minimum psi yield strength
10 per cent elongation

Grades B and D

65,000 minimum psi tensile strength
50,000 minimum psi yield strength
8 per cent elongation

Grades A and C

75,000 minimum psi tensile strength
60,000 minimum psi yield strength
5 per cent elongation

It will be noted, as would be expected metallurgically, that as both the tensile and yield strengths increase, the ductility decreases. These specifications do not cover all the grades of pearlitic malleable iron available, some being made with tensile strengths as high as 90,000 psi, with elongations in the proximity of 3 per cent.

This discussion is not intended as a criticism of the author's paper, but rather as additional information which may be of value to engineers in selecting a material for a specific purpose.

AUTHOR'S CLOSURE

Mr. Hindle's comments on developments in malleable cast iron represent a very valuable addition to the list of subjects included in this paper. The author regrets his oversight in failing to include this subject and is grateful to Mr. Hindle for calling attention to it. He also hopes that this introduction of such information in the discussion will help to rectify its original omission.

ARCHIBALD BLACK.[6]

[6] Manager, Mechanical Engineering Department, Simmonds Aerocessories, Inc., New York, N. Y. Mem. A.S.M.E.

Cost of Fabricating Boilers and Pressure Vessels

COMMENT BY G. J. SCHOESSOW[7] and H. E. EIFORT[8]

The recent paper[9] by Dr. Theisinger illustrates very clearly the advantages of selecting the proper width and length of plates and the number of courses that should be used in laying out the shell of a pressure vessel for most economical arrangement. This is well covered by the data presented by the author in which his particular considerations were as follows:

(*a*) Cost of the plate
(*b*) Cost per foot of welded seam.

Basically, these are two extremely important items of cost in a pressure vessel and were undoubtedly selected for that reason. Evidently the author chose to avoid complication in the paper by leaving out other factors which are also very important and influence the final selection of the plate width. Some of the factors that the author did not consider are as follows:

1 The investment which the manufacturer has in pressing and rolling equipment and the limitations of that equipment. Generally, each manufacturer has accumulated certain presses and rolls which have limitations such as the minimum diameter they can form, the maximum length they can handle, and the maximum thickness that the strength of the equipment will accommodate. Quite often an analysis made by a manufacturer, taking into account these items, will dictate to a large extent the plate width and length that he must use in the construction of the vessel, and generally he is not at liberty to use the plate width and length that works out most economically on the basis of the considerations that the author has presented. This is particularly true of vessels in the high-pressure or thick-wall classes.

2 The welding and radiographic equipment that the manufacturer has available will often influence the selection of plate width and length so as to result in the best economics of welding and X-raying. For very thick-walled vessels in which the X-ray exposure time and welding difficulties are serious considerations, it is usually best to start laying the design out using the largest-size plates that the plate mill can supply.

3 For thin-walled vessels, the introduction of single-pass welding as a consideration may alter the cost per foot of weld in relation to some of the basic data in figures and tables given in the paper.

4 In the field of boiler drums, it is now quite common to make the drum with a tube plate that is pierced with tube holes, and a wrapper plate that has very few holes. The tube plate is generally 2 to 3 times as thick as the wrapper plate. This construction saves weight and is a vital consideration on all portable boilers. It also is a vital consideration in saving steel. This tube-and-wrapper-plate construction requires the use of two longitudinal seams with the thick tube plate being machined down on a taper to join with the thin wrapper plate so that the center lines of the two plates coincide. The longitudinal weld then has the thickness of the thin wrapper plate. This thinner longitudinal weld saves welding and X-ray costs and of course has a great influence on the matter of selecting plates of proper width and length to make the drum.

5 Another important feature in the selection of the proper plate width and length to make a vessel, and the first consideration that must be given to the design is to determine the required diameter and length of the vessel. Sometimes this diameter and length are set by the geometrical dimensions of other parts of the structure into which the vessel must fit. At other times the dimensions are determined purely on the basis of lowest cost, in dollars per cubic foot of capacity in the vessel. When this occurs, it is a difficult hurdle for a designer to surmount. The author assumes that this decision has been made and the designer knows the diameter and length of shell required. Then by using the data in the paper, he can proceed to select the economical plate width and length.

In Figs. 14, 15, and 16, the paper covers a few plate thicknesses and diameters and indicates to anyone who uses such data the possibility of making up additional charts to include vessels of other proportions. In this respect the paper should prove valuable to manufacturers who will take the time to analyze it and prepare additional data along the same lines, extending the data to include their own manufacturing techniques, equipment limitations, etc.

The author has made an excellent presentation of a difficult subject and in such a way that the data may be readily checked.

COMMENT BY EDWARD WALKER[10]

The following questions are submitted for the author's consideration:

What is the comparable cost of building unfired pressure vessels in accordance with Paragraph U-68, U-69, and U-70 of the Unfired Pressure Vessel Code?

What per cent of the cost of vessels is

[7] Engineer, The Babcock & Wilcox Company, Barberton, Ohio. Mem. A.S.M.E.

[8] The Babcock & Wilcox Company, Barberton, Ohio.

[9] "Fabrication Costs of Boilers, Tanks, and Pressure Vessels, as Affected by Width of Plates," by W. G. Theisinger, MECHANICAL ENGINEERING, vol. 67, 1945, pp. 247–254.

[10] Examining Engineer, State of New Jersey Department of Labor; Engineers' License, Steam Boiler, Pressure Vessel, and Refrigeration Inspection Bureau.

charged to stress-relieving, according to Paragraph U-68?

What is the comparable cost of X-raying and trepanning welded joints?

What per cent of welded joints in vessels built according to Paragraph U-68 must be cut out due to porosity and rewelded again?

COMMENT BY S. V. WILLIAMS[11]

While we have always been a strong supporter of welding, and have fostered its application in all the various industries, we realize the importance and the economy to be derived from the use of correct plate sizes.

However, we should like to point out that in the early days of welding, when the plate material was being challenged as to its actual strength and freedom from internal flaws, which were readily revealed by welding, it became necessary to pay a premium for plate material, which had been sufficiently cropped to eliminate piping and segregations. We feel that welding has been an excellent tool for the inspection of plate material and has been instrumental in improving its quality.

With modern methods of inspection, such as X ray and magnaflux, efficiency of the welds has been improved so that values approaching that of the steel plate are permitted by the codes. It is doubtful, however, whether the efficiency of the joint will ever be permitted to equal that of the plate material, and on this basis alone, one would naturally select plates of maximum size.

However, by good design, which would logically imply the use of the best and most suitable size of plates, we know that our finished structure can be made to utilize the full value of the plate material. This is particularly true in the case of structures, containers, or vessels, which are subjected to internal corrosion. Here we have adequate proof that the life of the weld, when properly made, will be greater than that of the plate material.

In making this statement, we refer to the entire cross section of both the weld and the plate material, and not to the surfaces.

The author's comments on composite plates on clad steel have been noted and here again we agree that the savings to be made in larger-size plates are more pronounced.

In making the composite welds, unless the joint is correctly designed the possibility of contamination of the weld metal is great. Thus the physical properties might jeopardize the efficiency of the weld, and the finished structure. These can be controlled completely. However, the cost of carrying this out would run into considerable money, particularly as the cladding material demands highly expensive welding electrodes.

In this study the author has not specifically pointed out whether his welding cost was figured on submerged arc welding, or multiple-pass electrode welding. This again would greatly affect the cost. In general, however, we feel his studies are essentially correct.

[11] Manager, Shell Division, Struthers Wells Corporation, Titusville, Pa.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Small Business Is Big Business

ESTABLISHING AND OPERATING A METAL WORKING SHOP. By William H. Myer and Associates. Bureau of Foreign and Domestic Commerce, U. S. Dept. of Commerce, Washington, D. C., Industrial Series No. 16, 1945. Paper, $5^7/_8 \times 9^1/_8$ in., 202 pp., illus. For sale by Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., $0.35.

REVIEWED BY ALLAN R. CULLIMORE[1]

THIS pamphlet of slightly over two hundred pages is one of a series "initially prepared by the Bureau of Foreign and Domestic Commerce at the request of the War Department. They were intended for use in certain educational activities of the Armed Forces, and distribution was limited to men and women on active duty in the services. The cost of their preparation was borne by the War Department. In order to make these manuals available for general distribution to the public, the War Department has authorized the use of the original type and half tones by the Bureau."

The importance of this publication cannot be judged apart from its place in the general picture of rehabilitation. Factual material covering many fields must be furnished to veterans and displaced warworkers so that they may have information which will enable them to make such adjustments as seem to be advisable and take their proper place in the postwar picture.

It was very evident in the last war and just as evident in this that many veterans and warworkers as well had acquired certain skills in the Army or certain civilian experiences which made it advisable for them to operate small businesses. Very often the economic factor was such that small family businesses were indicated. The type of these varied over a very wide range from, perhaps, a sandwich counter to a very intricate metalworking shop.

Most veterans and others who desire guidance in this field find very little factual material suited to their particular needs, and it has been the reviewer's opinion for some time that a series of such pamphlets as this should be immediately distributed as widely as possible. It seems that it would be wasteful to put them in the hands of every warworker and returned veteran, but they could and should furnish a basis for factual information disseminated at information and referral centers throughout the country. They should be a part of the guidance library of every high school, in the hands of those people who undertake to point out possible roads of approach to economic security.

Much has been written and said concerning big business and its handling of the veterans. Much has been said and much under cover has been thought concerning the problems which surround the demoted warworker, but in many quarters the fact has been lost sight of that, really, the biggest business in this country is small business.

There is another side to the picture which deserves perhaps some consideration as well, and that is, in making the adjustments which a veteran has to make or the parallel adjustments which a warworker has to make, the small business may make more of a definite contribution than any other factor in the problem. It should be borne in mind that all these adjustments are directly personal ones, adjustment of an individual to an external situation. No adjustment can be made except by the individual himself, and it very often happens—the reviewer is tempted to say it most often happens—that individual adjustment is more easily made and can be

[1] President, Newark College of Engineering, Newark, N. J. Mem. A.S.M.E.

more definitely made where the individual has some considerable control over the external circumstances that press so hard upon him.

Even those of us who seem to be so well adjusted, so normal in our business contacts, would give a good deal sometimes to be able to shut up shop, close the door and go home, or go fishing, knowing that we had the right and the authority to compensate in this way. When those veterans and warworkers have to get used to things over again, in a good many cases it is going to be easier to do the thing in a small business rather than in a large industrial organization.

With these things in the picture, it is hoped that these pamphlets will be expanded to cover a wide field and that it will be possible to distribute them so that they will be in the hands of many people who have to do with guidance in its broadest phases. Our great difficulty now in rehabilitation, readjustment, or redirection or guidance—as you please to call it—is not that people don't want to help but, in the main, no one man or no one group has access to factual evidence which covers the field as a whole. The direction and information which is given at the best is not complete, sometimes pitifully incomplete, and the wide distribution of pamphlets of this type will serve to obviate one of the most important difficulties in the present plan of postwar readjustment.

Inspection and Quality Control

MANAGEMENT OF INSPECTION AND QUALITY CONTROL. By J. M. Juran. Harper and Brothers, New York, N. Y., 1945. Cloth, $5^1/_4 \times 8^1/_2$ in., 233 pp., $3.

REVIEWED BY JOHN GAILLARD[2]

THE war-production effort and consequent large-scale interweaving of activities of thousands of manufacturing concerns has made it necessary for many of them to take up, or refine, their organization for establishing and maintaining control of quality of their product. During the last few years, the term "quality control" has come to mean, in many industrial concerns, not merely the methods and equipment used for the inspection of individual units of product, for example, by gaging, but also the use of the control-chart method. This method aims primarily at removing from the production process, at the earliest possible moment, any cause of trouble that might spoil the quality of the product being made. While the older method of quality control was intended to sort bad product from good, the modern approach applied by means of the quality-control chart is to *prevent* the occurrence of bad product by nipping in the bud the development of any cause of rejections. The complete setup of modern quality control, involving methods, equipment, and personnel, presents an intricate picture which has been clearly analyzed and developed in only relatively few concerns.

During the last twenty years the Bell Telephone Laboratories and the Western Electric Company have done pioneer work in this field, the former in developing modern quality-control methods and the latter, in applying them in manufacturing practice. The author has drawn on his wide experience in the Western Electric Company which includes the purely technical, as well as the managerial aspects of the quality-control problem. Accordingly, the book deals with matters ranging from those which are the concern of top management, such as the assignment of departmental functions, to elementary inspection problems, like the acceptance or rejection of a small screw or a soldered connection. With all of these matters, the author deals in simple language and in an interesting, informative, and often colorful way. Therefore, this reviewer believes that the executive and the shopman may equally enjoy the book and benefit by the ideas developed in it. In fact, it is hoped that the book may be an incentive for many an industrial executive to focus his attention on the need for systematic organization of quality control in his company. There are still too many concerns where even the "traditional" form of quality control, such as the use of a proper limit system and its maintenance by gaging inspection, leaves much to be desired, not to speak of the modern approach by means of the quality-control chart. Study and remedy of such a condition will always prove to be a profitable investment, not only financially, but also in terms of good will on the part of the company's own personnel and its customers.

Rightly, the author stresses the importance of the human element and the necessity of maintaining the maximum possible degree of flexibility in compliance with quality specifications. In this respect, a statement from the chapter on Quality-Mindedness may be quoted here. It says: "The principal force for securing compliance with the specifications lies *not* in the gages, instructions, or other facilities for inspection. It lies in the state of mind of the plant personnel, from the top executive down to the man at the machine." As Kipling has said, it is "the everlasting teamwork of every blooming soul" that counts, and whoever wants to build up such teamwork in applying quality control will get some very valuable ideas from Dr. Juran's book.

[2] Mechanical engineer, American Standards Association, New York, N. Y. Mem. A.S.M.E.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by A.S.M.E. members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Harrison W. Craver, Director, Engineering Societies Library, 29 West 39th St., New York, N. Y.

Aircraft Armament

AIRCRAFT ARMAMENT. By Louis Bruchiss. Aerosphere, Inc., New York, N. Y., 1945. Cloth, $8^5/_8 \times 11^1/_2$ in., 224 pp., illus., $6.

REVIEWED BY G. M. BARNES[3]

Mr. Bruchiss has succeeded in collecting a great mass of data concerning aircraft cannon ammunition, bombs, gun turrets, rockets, and other types of aircraft armament. This has been a very difficult task for Mr. Bruchiss because a great deal of this information has until recently been considered confidential by the War and Navy Departments and very little has been written concerning these various items. The limited data available have been widely scattered through various government publications and instruction pamphlets for men in the field.

The author therefore deserves a great deal of credit for having so painstakingly assembled these data for the information of those who would be interested in this field of engineering.

This book will be of interest to all Ordnance officers and engineers who are studying aircraft armament. It shows the great field of weapons and ammunition which has been covered by the Ordnance Department in equipping the Army and the Navy with aircraft armament of outstanding reliability and battle efficiency in this war.

[3] Major General, Ordnance Department, Chief of Research and Development Service, Office of the Chief of Ordnance, War Department, Washington, D. C. Mem. A.S.M.E.

Books Received in Library

AIR NEWS YEARBOOK, Vol. 2. Edited by P. Andrews. Duell, Sloan and Pearce, New York N. Y., 1944. Cloth, 9 × 12 in., 296 pp., illus., $4.75. Extensive chapters on the development and operation of the air forces of the principal world powers are illustrated by some four hundred photographs. Individual descriptive material is provided for all planes shown, and plane types are arranged according to the countries of their origin.

AMERICAN MALLEABLE IRON, a Handbook. Malleable Founders' Society, Cleveland, Ohio, 1944. Fabricoid, 6 × 9 in., 367 pp., illus., diagrams, charts, tables, $4. All phases of the malleable iron industry are covered in this handbook. The early chapters deal with its constitution and properties. Succeeding chapters take up casting and machining practice, manufacture, and metallurgy. Nearly one hundred pages of engineering tables and data provide needed information. A brief history of the industry, a glossary, and a bibliography of source material are included.

CUTTING TOOL PRACTICE. By H. C. Town and D. Potter. Paul Elek (publishers) Ltd., London, W.C. 2, England, 1945. Cloth, 5½ × 8½ in., 131 pp., illus., diagrams, charts, tables, 13s 6d. Recent developments in metal-cutting tools are described for both single-point and multi-cutting tools for high production work. Special topics covered include down-cut and negative rake milling, drilling of square and hexagon holes, specialized hobbing, and diamond tools. The characteristics of cutting materials are discussed with information on sharpening and heat-treating practice.

EBULLIOMETRIC MEASUREMENTS. By W. Swietoslawski. Reinhold Publishing Corporation, New York, N. Y., 1945. Cloth, 6 × 9¼ in., 228 pp., illus., diagrams, charts, tables, $4. A comprehensive description is given of the ebulliometric method for measuring the boiling and condensation temperatures of liquids and solutions. Practical applications discussed include the determination of degree of purity of liquid substances, examining the azeotropy of binary and ternary mixtures, molecular weight work, microanalytical impurity determinations, boiling and condensation phenomena under high pressure, and the examination of physico-chemical standards. The expanded use of these methods in everyday industrial research is indicated by the author.

FUNDAMENTALS OF THERMODYNAMICS. By A. S. Adams and G. D. Hilding. Harper & Brothers, New York, N. Y., and London, England, 1945. Cloth, 6 × 9½ in., 289 pp., diagrams, charts, tables, $3.75. The object of the authors is to give the beginning student an understanding of the fundamentals of thermodynamics adequate for further related study in mechanical engineering, physics, and chemistry. Separate chapters are devoted to compressed air, the Otto and Diesel cycles, and steam cycles. Many worked-out practical examples are included.

SYNTHETIC RUBBER FROM ALCOHOL, a Survey Based on the Russian Literature. By A. Talalay and M. Magat. Interscience Publishers, New York, N. Y., 1945. Cloth, 6 × 9¼ in., 298 pp., diagrams, charts, tables, $5. The material presented in this book is the result of a survey based on the Russian literature, although references are included from other sources. Chapter 1 discusses the Bebedev catalysis. Chapter 2 details the technology of the S.K. process. Polymerization reactions are dealt with at some length in chapter 3, while the final chapter devotes nearly one hundred pages to the physiochemical properties of the polymer.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of June 29, 1945, and approved by the A.S.M.E. Council on July 27, 1945.

CASE No. 1021 (*Special Ruling*)

Inquiry: There is considerable evidence that the addition of 0.5 per cent chromium to carbon-molybdenum steel, plus a limitation of the aluminum addition for deoxidation, plus a limitation on austenitic grain size will inhibit graphitization of the material under conditions of high temperature service. Some of the factors involved are not definitely known and considerable work is being done in investigating the causes for graphitization and the most practicable means for preventing it. A new specification for seamless chromium-molybdenum steel pipe for service at high temperatures is being developed by the American Society for Testing Materials, but has not yet been approved. In view of the fact that immediate use is being made of the chromium-molybdenum type of material for new and existing boiler installations operating at temperatures over 900 F, will it meet the intent of the Code if a new grade were added to the following specifications to include a chromium content of 0.40 to 0.60 per cent: SA-204, plates; SA-217, Grades WC1 and WC2, castings; SA-182, Grade F1, forgings; SA-206, seamless pipe. The application would be to Par. P-103 and to Table Q-5. There would be no change in the allowable stress as given in Tables P-5 and P-7 from that for carbon-molybdenum without the chromium.

Reply: Pending approval of new specifications and the revision of existing specifications to include the chromium addition, it is the opinion of the Committee that the proposed chromium addition to carbon-molybdenum specifications will meet the intent of the Code.

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph number to identify their location in the various sections of the code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-200. Revise last sentence of first section to read:

All staybolts not normal to the stayed surface shall have not less than three engaging threads of which at least one shall be a full thread. [but] If the thickness of the material in the boiler is not sufficient to give one full engaging thread the plates shall be sufficiently reinforced [on the inside by a steel plate riveted thereto] EITHER BY:

(1) RIVETING A STEEL PLATE ON THE WRAPPER SHEET; OR

(2) SEAL WELDING A PLATE WASHER, FORGING, OR STEEL CASTING TO THE OUTSIDE OF THE WRAPPER SHEET, PROVIDED THE THICKNESS OF THE CROWN SHEET DOES NOT EXCEED 7/16 IN., THE WELD METAL IS DEPOSITED IN A SINGLE LAYER HAVING A THROAT THICKNESS OF NOT LESS THAN 3/16 IN., NOR MORE THAN 5/16 IN., AND CONTINUOUS THREADS EXTEND THROUGH BOTH THE ATTACHMENT AND THE WRAPPER SHEET. THIS WELD NEED NOT BE STRESS-RELIEVED OR X-RAYED.

PAR. U-13(c)(4). Revise to read:

(4) The carbon content from check analysis taken from ONE OF the two tension-test specimens shall not exceed 0.31 per cent.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

The Cincinnati Section of the A.S.M.E. to Hold Special Fall Meeting, Oct. 2-3

In Lieu of the Regular Fall Meeting of the Society, Banned by O.D.T. War Regulations

TO GIVE members the benefit of papers which under ordinary conditions could be obtained by attendance at a regular Fall Meeting of the A.S.M.E., a two-day meeting of the Cincinnati Section of the Society has been arranged for Tuesday and Wednesday, October 2 and 3 with headquarters at the Hotel Netherland-Plaza.

To Attract Local Attendance

The Cincinnati Section had hoped this year to be host to a national meeting as it had also hoped to be last year but since national meetings are barred by travel restrictions, this meeting is scheduled to attract attendance only by members who are located in that city or its suburban area. This is being done in accord with both the spirit and the letter of the O.D.T. ruling on meetings.

Papers in Many Fields

While the entire program is not yet completed it promises to include papers of value in the fields of power and fuels, plastics, management, applied mechanics, metals engineering, metal cutting and cutting fluids, and aviation. Plans have also been made for visits to two important plants in the area—the Cincinnati Milling Machine Company and the Wright Aeronautical Company, each of which will require a full afternoon.

D. Roy Shoults to Speak

Two luncheons and a dinner are being arranged with speakers who will deliver important messages on current problems. Mr. D. Roy Shoults, vice-president, Bell Aircraft Corporation, Buffalo, N. Y., will speak at the luncheon on Wednesday on "Airplanes of the Future and the Future of the Airplane." This talk will be illustrated by technicolor moving pictures. It will describe the advent of jet propulsion of aircraft, the development of the helicopter, the creation of huge superbombers, and giant air transports. What these new airplanes will be like and what impact they will have on our way of life are interesting subjects for speculation. Mr. Shoults was until recently engineer of the aviation division of the General Electric Company and has been intimately associated with wartime aircraft development, particularly with that on jet propulsion.

Metal Cutting Data and Cutting Fuids

Some of the papers to be presented and which may now be announced include those to be sponsored by the Special Research Committee on Metal Cutting Data and Bibliography and Cutting Fluids.

"The Face-Milling of Cast Iron," by O. W. Boston and W. W. Gilbert, University of Michigan

"Data on Production Runs With Carbide Milling Cutters," by A. O. Schmidt, Kearney & Trecker Corporation, Milwaukee, Wis.

"Analysis of Initial Contact of Milling Cutter and Work in Relation to Tool Life," by M. F. Kronenberg, Cincinnati Milling Machine Co.

"Experience With Carbide-Tipped Tools," by M. E. Feldstein, Delco Products Co., Dayton, Ohio

"Speed and Feed Selection in Carbide Milling With Respect to Production, Cost, and Accuracy," by Hans Ernst and M. Field, Cincinnati Milling Machine Co., Cincinnati, Ohio

"Some Effects of Work Positioning When Face-Milling Steel," by F. W. Lucht, The Carboloy Company, Detroit, Mich.

"Facts on the Use of Cutting Fluids," by William H. Oldacre, president, D. A. Stuart, Oil Co., Chicago, Ill.

"Single-Point Turning Research, Equipment and Methods Involved," by Joseph Allen, Warner & Swasey Company, Cleveland, Ohio

"Nomograph for Analysis of the Orthogonal Metal-Cutting Process Producing a Continuous Chip," by M. E. Merchant and Norman Zlatin, Cincinnati Milling Machine Co.

Management

Management papers scheduled for the meeting include:

"Work Simplification," by S. M. Lowry, Methods Engineering Council, Pittsburgh, Pa.

"Planning for a Better America: Program of the C.E.D.," by Millard Romaine, Cincinnati Milling Machine Co.

"The Impending Scarcity of Scientific Personnel," by M. H. Trytten, Director of Office of Scientific Personnel, National Research Council

"How Can the University Meet the Shortage of Scientific Personnel," by Raymond Walters, president, University of Cincinnati

Fuels

Under the sponsorship of the Fuels Division two papers are to be presented:

"Pressure Combustion," by I. D. Groak, Groak Engineering Co., Chicago, Ill.

"Elimination of Smoke on Locomotives," by E. D. Benton, Louisville & Nashville Railroad Company, and R. B. Engdahl, Battelle Memorial Institute, Columbus, Ohio

Metals Engineering

The Metals Engineering Division will provide two papers for discussion at the meeting as follows:

"The Cohesive Strength of Steel," by George Sachs, Case School of Applied Science, Cleveland, Ohio

"Stress Corrosion Studies on Cast Iron," by John Urban, C. B. Olson, J. W. Bolton, and A. J. Smith, Lunkenheimer Company, Cincinnati, Ohio

Plastics

At the session on plastics there will be two papers which are to be sponsored by the Rubber and Plastics Division.

"Selecting a Plastic," by R. N. Backschiever, Recto Molded Products, Inc., Cincinnati, Ohio

"Laminated Plastics," by G. H. Clark, Formica Company, Cincinnati, Ohio

Applied Mechanics

The Applied Mechanics Division will present two papers at the meeting:

"Theoretical Analysis of Perforated Shear Webs," by Chu-Kia Wang, U. S. Bureau of Reclamation, Denver, Col.

"Application of Lagrangian Dynamics to Engineering Problems," by D. A. Wells, University of Cincinnati

Transportation

The Railroad Division is making plans to present one paper at the final session of the meeting:

"Design of Passenger Equipment," by A. M. Unger, Pullman Standard Car Co., Chicago, Ill.

How to Obtain Complete Program

Since the next issue of MECHANICAL ENGINEERING will not be in the mails sufficiently ahead of the Meeting, members interested in receiving copies of the complete program should write to the chairman of the Cincinnati Section, M. E. Martellotti, Cincinnati Milling Machine Company, Cincinnati, Ohio, who has the arrangements in his charge.

Actions of A.S.M.E. Executive Committee

At Meeting Held at Headquarters July 27, 1945

A MEETING of the Executive Committee of The American Society of Mechanical Engineers was held in the rooms of the Society, New York, N. Y., July 27, 1945. There were present: Alex D. Bailey, chairman, who presided, R. F. Gagg, vice-chairman, and Alton C. Chick, of the Committee; J. J. Swan (Finance), A. R. Mumford (Sections), J. H. Sengstaken (Professional Divisions), E. J. Kates (Publications), G. L. Knight (Pension), S. F. Voorhees (Hoover Medal Board of Award), and P. T. Onderdonk (Joint Committee on Economic Status of the Engineer); C. E. Davies, secretary, Ernest Hartford, executive assistant secretary, George A. Stetson, editor, and R. L. Sackett, assistant to the secretary.

The following actions were of general interest.

Meetings

The Committee voted to hold a local meeting in New York, in place of the 1945 Annual Meeting, with Council and business meetings, starting the week of November 26, 1945.

Approval was voted of a resolution of thanks and appreciation to all who contributed to the meeting held by the Chicago Section, June 17–19, 1945.

Approval was voted of a recommendation of the Committee on Meetings and Program that there should be a charge for preprints of meeting papers. This policy is to be reconsidered later in connection with postwar planning.

Election of Fellows

The Committee accepted the recommendation of the Committee on Admissions that action on candidates for the Fellow grade of membership should be taken monthly.

Research

Approval was voted of renewal of the cooperative agreement between the Department of the Interior, for the U. S. Bureau of Mines, and the Society, for the Research Committee on Furnace Performance Factors.

Appointment was authorized of a Special Research Committee on Theory of Automatic Process Control.

Discharge of Committees

Two special committees, Society Organization Structure and Office Operation, whose work has been completed, were discharged with thanks and appreciation.

Organization

On the recommendation of the Committee on Organization approval was voted of the establishment of a Board on Codes and Standards.

Appointments

The following appointments were approved:

Standardization, F. Hugh Morehead (five years).

Research Committee, Ernest L. Robinson (five years).

Finance Committee, Alton C. Chick, Council representative (unexpired term of H. G. Thielscher.)

Library Committee, George F. Bateman (four years).

Education and Training for the Industries, O. D. Montgomery, advisory member.

Research Committee on Finishing and Machining High-Explosive Shells, D. W. Fletcher, chairman, R. W. Biggs, secretary, O. W. Boston, W. C. DeGraff, M. S. Evans, D. M. Galloway, Charles G. Grazioso, W. N. Howley, M. L. Katke, M. D. Stone, and W. Trinks. Advisory members, Brig. Gen. R. E. Hardy, Capt. P. H. Sweet, Arthur Adelman, and W. R. Jamison.

Professional Divisions: Management, William R. Mullee (five years); Oil and Gas Power, G. C. Boyer (five years); Production Engineering, A. F. Murray (five years); Rubber and Plastics, J. F. Downie Smith; Textile, E. L. McCormack (five years); Consulting Engineering Group, P. L. Batty, W. H. McBryde, F. H. Prouty, and M. X. Wilberding.

Tellers, Election of 1946 Officers, Paul Diserens, Henry L. Lardner, Harvey E. Molé, and R. L. Sackett, alternate.

Research Procedure, Engineering Foundation, W. Trinks (reappointed, one year).

Engineers' Council for Professional Development, John E. Younger, (three years).

Public Works Construction Advisory Committee of Federal Works Agency, M. X. Wilberding, alternate to S. Logan Kerr.

N.A.C.A. Announces New Supersonic Wind Tunnel for Jet-Propulsion Research

FUNDAMENTAL research on aircraft propulsion plants operating at equivalent sea-level velocities up to and beyond 2000 miles per hour is now being conducted in a new type of supersonic wind tunnel recently completed at the National Advisory Committee for Aeronautics (N.A.C.A.) aircraft propulsion research laboratory in Cleveland.

The new N.A.C.A. wind tunnel is a unique research facility for investigating at supersonic velocity the operating characteristics of models of turbo-jet, ram-jet, and similar engines expected to propel aircraft and guided missiles through space at speeds hitherto unrealized except by projectiles shot from guns.

Dr. Jerome C. Hunsaker, honorary member A.S.M.E., chairman of the N.A.C.A., points out that aviation is entering an era of revolutionary change resulting from the development of new methods of propulsion. The new propulsion systems open up extraordinary high-speed possibilities.

Dr. George W. Lewis, Director of Aeronautical Research of the N.A.C.A., in discussing the application of the new Cleveland tunnel, revealed that many of the projected propulsion systems should have sufficient thrust to take aircraft well into the supersonic speed range. Those which depend on outside air for combustion, such as turbo jets and ram jets, must handle vast amounts of air at such high speeds as to change entirely the nature of air flow as we now know it. The new supersonic propulsion research wind tunnel provides the only means we have of determining what the requirements are for the design and operation of these new propulsion plants at the high speeds for which they seem most promising.

This supersonic wind tunnel, along with the altitude wind tunnel, extends the propulsion research capabilities of N.A.C.A.'s Cleveland Laboratory to extremes of both altitude and speed. The altitude wind tunnel is unique in that it permits investigation of the operating characteristics of full-sized jet engines and gas turbines as well as conventional engines at altitudes up to 50,000 ft. The humidity, temperature, pressure, and density conditions of extreme altitudes are simulated at air speeds up to 500 miles per hour. The extension of propulsion research into the supersonic speed ranges was accomplished by constructing the new supersonic propulsion research tunnel as an integral part of the altitude wind tunnel. The latter's extensive air-drying and low-temperature apparatus are utilized to provide the required dry air for the supersonic tunnel; and its powerful exhauster installation is utilized to suck air through the supersonic wind tunnel at very high velocity.

The tunnel has a cross section of two and a quarter square feet, through which air moves at extremely high speed. In the tunnel the model propulsion device is mounted in such a way as to measure the aerodynamic forces on it, as well as the thrust developed. Complete instrumentation is provided to determine performance characteristics with various fuels at different speeds and other operating conditions.

Schlieren camera apparatus is used to record air flow and compressibility effects on the model. This apparatus acts to magnify, delineate, and photograph the pressure lines of air flow so that means of securing both the proper aerodynamic shape as well as the directing of combustion and cooling air into the propulsion plant can be studied.

Abe Silverstein, chief of the engine installation division of the N.A.C.A. Cleveland laboratory, designed the supersonic tunnel installation. E. R. Sharp, manager of the Cleveland laboratory, supervised the entire project, which was carried through from conception to completion in the record-breaking time of ninety days.

The supersonic wind tunnel now operating is actually one of the two undertaken at the same time. The second, of circular cross section, will soon be in operation. It parallels the first and utilizes the same air and power sources.

Batt and Dodd Head A.M.A.

THE new officers of the American Management Association, recently announced, are: William L. Batt, past-president and honorary member, A.S.M.E., vice-chairman of the War Production Board, and president of SKF Industries, Inc., who will continue as chairman of the Board of the Association; Thomas Roy Jones, president, American Type Founders, Inc., vice-chairman, and Alvin E. Dodd, president. Keith S. McHugh, vice-president, American Telephone & Telegraph Co., becomes chairman of the Executive Committee of the Association.

Joint Engineering Society Participation in the Program of the Committee for Economic Development (C.E.D.)

THE title group is a privately sponsored planning organization co-operating with the nation's chambers of commerce and other nonpolitical bodies. Its immediate purpose is to steer reconversion down an economically wholesome channel, using the best intellectual resources in the country.

War production has been successful largely because of America's superb technical talent. The chemists, physicists, architects, and engineers now furnishing the means for war production are the same men who will have to guide the country toward a high-level peacetime standard of living. Confusion, unemployment, and uncertainty can be minimized by the same kind of analytical thinking we practiced for war production. Quite briefly, this is the philosopy of the Committee for Economic Development. Stated negatively, it may be said that random or politically expedient planning will breed make-work programs, stifle initiative, and reduce our living standard to a point where some form of totalitarianism will take root.

The C.E.D. reasons that productivity and hence the goal of high-level employment will both await construction of requisite plants and facilities. In fact, reconversion is only accomplished when new plants and modified war facilities are operating at designed capacity.

Most Urgent Planning Is for Construction

Accordingly, the most urgent planning is for construction. Because it takes twice as long to design a structure as to build it, the time for such design is now.

The C.E.D. has established an Action and Advisory Committee on Construction, with which the American Society of Civil Engineers has been working for more than a year. A tremendous volume of statistical data has been collected, about which ample publicity will be found elsewhere. Suffice it to say that test surveys are partially completed in more than 60 cities with some individual results completely reported. This sampling will be used as the basis for a general study to determine what each community postwar construction program is, and to encourage the development of plans not already under way. A rough classification between private industrial, private commercial, private housing, and public construction is asked in each survey.

This work is handled through community C.E.D. organizations numbering nearly 3000. All 61 U. S. local sections of the American Society of Civil Engineers have assisted materially by active assignment of men to neighboring C.E.D. community organizations.

Engineering Societies Co-Operate

But now the energetic participation of the other professional societies is required to accelerate community planning and to push designs to the "ready-for-bids" stage. The officers of the following societies have appointed representatives to co-ordinate effort and to familiarize all members with the scope, significance, and urgency of the C.E.D. program:

American Society of Civil Engineers, Malcolm Pirnie and Dean G. Edwards

American Institute of Architects, Arthur C. Holden

American Institute of Mining and Metallurgical Engineers, E. A. Prentis, Jr.

American Institute of Electrical Engineers, Gano Dunn

American Institute of Chemical Engineers, C. R. Downs

The American Society of Mechanical Engineers, Robert S. Hackett

Every A.S.M.E. Member Can Help Locally

At a meeting in New York, July 20, 1945, these representatives agreed with C.E.D. that there was no need to set up society organizations. The job requires support of existing efforts in each community. The C.E.D. and various chambers of commerce are ready and waiting for the technical advice and help our Society members can provide.

The A.S.M.E. is not given to amateur exercises of its members' talents. Solicitation of time and effort in this case is officially sanctioned as an imperative demand for the Society's welfare. Each member has an opportunity to serve himself, his employer, his Society, his community, and his country through the C.E.D. development. Furthermore, this is the most significant instance of joint-engineering-society effort thus far in our respective histories.

What to Do

If your employer's construction requirements are not secret, urge that the over-all estimates be sent to your local C.E.D. and suggest to your contractor that he discuss equipment and manpower requirements with the same committee. Ascertain which of the 3000 C.E.D. units is nearest you and volunteer whatever help you can afford. Public-works planning is well under way. Try to force privately sponsored contracts to the forefront, lest public projects absorb the country's construction capacity, thus delaying reconversion. The engineer's down-to-earth leadership is desperately needed in many communities where the only apparent postwar planning is in the realm of projects at federal, state, or local-government expense. Construction of productive facilities must come first.

May the public be as much impressed by our common contributions toward a sound economy as by our separate accomplishments in war production.—ROBERT S. HACKETT.[1]

[1] Engineer, U. S. Guarantee Co., New York, N. Y. Mem. A.S.M.E.

Stevens Honors Three A.S.M.E. Members

AT its commencement exercises held on June 27, Stevens Institute of Technology conferred the honorary degree of doctor of engineering on three members of The American Society of Mechanical Engineers: Capt. Arthur S. Adams, Livingston W. Houston, and Morris W. Kellogg.

Captain Adams, who gave the commencement address, has been in charge of the Navy's training program, including the V-12 college-training program, and is provost-elect of Cornell University.

Mr. Houston is president of Rensselaer Polytechnic Institute. Formerly president of the Ludlow Valve Manufacturing Company of Troy, N. Y., he is now a director and chairman of its Board.

Mr. Kellogg, president of M. W. Kellogg Company, New York, N. Y., has been a pioneer in the field of petroleum engineering. During the present war the Kellogg Company has built a considerable percentage of this country's high-octane gasoline plants, as well as other war plants for synthetic rubber and other uses.

J. R. Townsend Heads A.S.T.M.

AT the forty-eighth annual meeting of the American Society for Testing Materials, held at New York, N. Y., June 27, J. R. Townsend, materials engineer, Bell Telephone Laboratories, Inc., New York, N. Y., was elected president for the term of one year.

Other elections were: vice-president (two-year term), T. A. Boyd, head, fuel department, research laboratories division, General Motors Corp., Detroit 2, Mich.; members of executive committee (two-year terms), John R. Freeman, Jr., technical manager, American Brass Company, Waterbury 88, Conn.; L. J. Markwardt, assistant director, U. S. Forest Products Laboratory, Madison 5, Wis.; Carlton H. Rose, chemist, National Lead Company, research laboratories, 105 York St., Brooklyn 1, N. Y.; L. P. Spalding, chief research engineer, North American Aviation, Inc., Inglewood, Calif.; and William A. Zinzow, chief physicist, Bakelite Corporation, 230 Grove St., Bloomfield, N. J.

L. H. Kenney Honored by Brazil

WORD has been received that L. H. Kenney, member A.S.M.E., head marine engineer, Industrial Department, Navy Yard, Philadelphia, Pa., has been awarded the degree of officer of the National Order of the Southern Cross by the President of the Republic of the United States of Brazil. Evidence of the degree consists of a medal and diploma.

The degree was conferred on Mr. Kenney for his work in connection with destroyers for the Brazilian Navy. This work consisted in selecting equipment to be installed, reviewing bids, and preparing the necessary installation plans.

President's Page

Our Objective

IN any organization, particularly in one with the varied and growing interests of our Society, it is well to pause occasionally to see if we are properly directing our efforts and to determine how successful we have been in attaining our objective.

Part second of the Society's Charter, adopted in 1881, states our objective as follows: "The particular business and objects of such Society are, to promote the Arts and Sciences, connected with Engineering and Mechanical Construction for Scientific purposes, and to that end to meet and associate together to read and discuss professional papers, and to circulate by means of publications among its members, the information thus obtained, and for the purpose of maintaining a library."

The activities of our professional divisions and technical committees on research, codes, and standards, prove quite conclusively that we have been successful in attaining this objective. The increase in the scope of these activities, the number and variety of the subjects covered, and the increase in the number of individuals engaged in this work is indicative not only of its success, but of its increasing importance; the number of publications resulting from the work of these groups also proves the success of their efforts.

The work of the 2000 members of the technical committees covers a broad field, and the list of publications resulting from this work covers approximately 150 subjects. The variety of subjects under active consideration may be judged from the following abbreviated list: Forging of Steel Shells and Bombs, Metal Cutting, Furnace Performance Factors, Screw Threads, Rules for Construction of Boilers, Codes for Testing Prime Movers of many sorts, Safety Code for Elevators and other types of machinery, etc. At the present moment an unusual activity is in progress covering the standardization of screw threads and other machine elements, which is a joint program by engineers of Great Britain, Canada, and the United States.

The activities of the professional divisions are equally diversified and cover all the details of subjects ranging from Aviation, through Fuels, Management, Metals Engineering, Power, Railroad, Rubber and Plastics, Textile, and Wood Industries, to name only a few.

Our Society offers many opportunities, both to the younger engineer who wishes to learn from others and to the older engineer who wishes to record his experience for the benefit of others. These opportunities are offered in Society meetings planned by the twenty professional divisions and the numerous technical committees, the programs being co-ordinated by the Committee on Meetings and Program. The Publication Committee records the activities and reports which come out of these meetings.

This phase of our Society work is stressed at this time because, in attaining this objective, our Society is rendering a great service to its members, to industry, and to our national economic development. It is true that each year a greater number of our members are participating, but there is always a demand for men who are qualified to carry on some branch of these activities. The resources of the Society are being continually surveyed to find these qualified men. Each member who has special ability or knowledge of some branch of this work should offer his services as the benefit of his efforts will be twofold—he will gain from the contacts he makes and our Society will go further in attaining its objective as a result of his individual effort.

(*Signed*) ALEX D. BAILEY, *President, A.S.M.E.*

New A.S.M.E. Publications

THERE has just been published a 561-page "Bibliography on Cutting of Metals" prepared by Professor O. W. Boston for the A.S.M.E. Special Research Committee on Metal Cutting Data and Bibliography. It comprises the 700 references which were published in 1930 and 1935, respectively, and 3500 additional items, all sufficiently annotated to give an accurate outline of the contents of the articles. References are arranged chronologically and cover the most important articles published in books and periodicals on all phases of the subject and on such diversified subjects as machining of glass, heat-treating of tool steels, skin troubles affecting machine-shop operators, etc. Author and subject indexes are included. The book is published in the same format and binding as the "Manual on the Cutting of Metals," thereby enhancing its usefulness as a source of information on any particular subject not fully treated by the Manual. Price $6.50.

Oil and Automotive Diesel Engines

Those who require reliable "Cost and Performance Data on Oil and Automotive-Diesel Engines" will want copies of the recently published 1943 Reports. In the section on Oil Engines are: (1), the complete operating-cost figures for 149 oil-engine generating plants containing 447 engines; (2), information on type of plant, the equipment used, and conditions of operation; and (3), comparative costs for two or more years for 141 plants. Price $1.25.

The 1943 "Cost and Performance Data for Automotive-Diesel Engines" were supplied by owners and operators of 843 Diesel-powered vehicles and cover type of vehicle; type of service; number of engine road failures and causes; and cost per mile or hour for fuel, lubricating oil, and engine maintenance, etc. Price 25c net.

Power Test Codes Auxiliary Material

New additions to the A.S.M.E. Power Test Codes are the auxiliary pamphlets on "Definitions and Values, and General Instructions." The former provides the precise definitions of terms and the exact values of constants employed in the various Power Test Codes; while the latter, "Code on General Instructions," outlines general principles underlying the routine commercial and acceptance tests of power machinery. The Code on Definitions and Values is priced at 80 cents, while that covering General Instructions sells at 45 cents a copy.

Resistance Thermometers

To the Supplements on Instruments and Apparatus has been added Part 3, "Temperature Measurement," Chapter 4, "Resistance Thermometers." This pamphlet describes platinum, nickel, and copper resistance thermometers and discusses their range, accuracy, and construction, as well as their advantages and disadvantages when compared with liquid-in-glass thermometers. Price 80 cents.

Discount to Members

A 20 per cent discount is allowed to A.S.M.E. members on all prices here quoted, except that for "Automotive-Diesel Engine Cost Report."

New Guide and Specifications for Iron and Steel Arc-Welding Electrodes

THE continual increase in the applications of metal arc welding may in part be ascribed to the concurrent advance in the development of new and improved types of electrodes, each designed to do specific jobs in the most efficient manner. To provide for classification of the various types, the American Welding Society and American Society for Testing Materials have jointly undertaken the formulation of specifications for these materials.

The largest volume of electrodes produced is for the welding of mild and low-alloy steels. Electrodes of this type, identified by the well-known classification numbers E6010, E6011, etc., are covered in Tentative Specifications for Iron and Steel Arc-Welding Electrodes. This standard has been in use for several years and has been revised periodically. The most recent revision has just been completed. The new issue, carrying the designation A233-45T, embodies revisions which, while making some modification of previous test requirements, are primarily intended to clarify these test requirements by more specific definition of what is required for each classification and how the required tests are to be performed. For more ready reference, test conditions and results have been included in tabular form, and a new table has been added summarizing all test requirements.

In the course of preparing this revision it was recognized that there are many data on electrodes which, while not proper for inclusion in the specifications, would be useful to potential users in guiding them toward an understanding of the best suited applications for the various electrode classifications established by the specifications. To provide this information the "Guide to AWS-ASTM Classification of Iron and Steel Arc-Welding Electrodes" has been prepared to supplement the specifications and has been included as an appendix to them.

This Guide explains the concept of the classification numbering system used in the specifications and a discussion of each electrode classification in the E60 series as to type of coating, suitable currents and voltages, and mechanical properties. Also included is a list of codes with which each classification complies.

Individual copies of the revised specifications A233–45T and the appended Guide may be obtained from either the American Welding Society, 33 West 39th Street, New York 18, N. Y., or the American Society for Testing Materials, 260 South Broad Street, Philadelphia 2, Pa., at 25 cents per copy.

Navy Establishes Research Laboratories at Penn State

THE U. S. Navy has completed arrangements for the establishment of two permanent ordnance research laboratories which will be in operation by fall at the Pennsylvania State College under a Bureau of Ordnance contract. The establishment of these laboratories is in keeping with the Bureau of Ordnance broad policy of forming research affiliations with educational institutions to further development of naval weapons and for educational purposes in such military problems during the postwar period.

The Ordnance Research Laboratory, dealing with underwater ordnance, will be housed in the new building now under construction on the campus. The work will be a continuation of the research formerly carried on by the Underwater Sound Laboratory at Harvard University which has been sponsored by the Office of Scientific Research and Development, with technical direction from the Bureau of Ordnance. Dr. Eric A. Walker, who was in charge of the Ordnance Research Division at Harvard, will direct the new laboratory and also head the electrical engineering department of the College.

Assistant directors of the Ordnance Research Laboratory will be A. N. Butz, Jr., who formerly operated a private electronics research laboratory, R. R. Thompson, formerly associated with Bell Telephone Laboratories and the Humble Oil and Refining Company, and Dr. Harvey Brooks. All of these men are now affiliated with the Harvard University Laboratory. A staff of approximately 125 scientists, technicians, and clerks will be transferred from the Harvard Laboratory to the new unit. In addition to the work that will be carried on in the Ordnance Research Laboratory on the campus, this laboratory will also operate a calibration station at the Black Moshannon Lake, approximately twenty miles from State College, and a test station at Fort Lauderdale, Florida.

The Petroleum Refining Laboratory has been in operation for approximately sixteen years at The Pennsylvania State College. During the present war emergency it has also been under sponsorship of the Office of Scientific Research and Development. The plan is for this laboratory to continue with the petroleum research under a direct contract with the Bureau of Ordnance, including special work for and technical reports to the other services. Dr. M. R. Fenske will continue as director of the Petroleum Refining Laboratory, a position which he has held since it was established. Assisting Dr. Fenske is Dr. Dorothy Quiggle and R. A. Rush. Dr. Quiggle has been with the Petroleum Refining Laboratory since it was established and Mr. Rush since 1932. Both are faculty members of The Pennsylvania State College. The staff of the Laboratory includes more than fifty chemists, chemical engineers, and technicians.

The Ordnance Research Laboratory has been placed under the School of Engineering (H. P. Hammond, dean) by The Pennsylvania State College, and the Petroleum Refining Laboratory is under the School of Chemistry and Physics (F. C. Whitmore, dean). Most of the scientific and technical personnel will hold academic appointments on the faculty of the College.

U. S. Naval Postgraduate School

THE Chief of Naval Personnel recently invited a group of nationally recognized engineering educators to visit the U. S. Naval Postgraduate School at Annapolis, Md., for the purpose of inquiring into the character and scope of instruction presented at the Postgraduate School. The group also considered the propriety of authorizing the award of masters of science and doctors of science degrees to student officers who fulfill established requirements for these degrees. The educators who met at Annapolis with the head of the Postgraduate School, Captain H. A. Spanagel, U. S. Navy, were: Dean H. T. Heald (Illinois Institute of Technology), Dean Emeritus D. S. Kimball (Cornell), Dean W. B. Kouwenhoven (Johns Hopkins), Dr. R. S. McBride (E.C.P.D.), Dean E. L. Moreland (M.I.T.), Dean A. A. Potter (Purdue), and Dean H. M. Westergaard (Harvard).

During the meeting, the members of the group carefully analyzed the several curricula; inquired into the details of instruction, and the quality of the students; examined the schedules of both students and instructors; and inspected the facilities of the Postgraduate School. The keen interest in the Navy's postgraduate training program displayed by these educators and their constructive criticism will be of inestimable value in arranging the Navy's postwar plans for graduate education of its officers.

The Navy has long recognized the value of advanced technical education, with specialized training to meet specific Naval needs. The Postgraduate School was established at the Naval Academy for this purpose in 1909. The School has continued since that time, except for a brief period during World War I. It has grown from a small staff and a few students until the number of officers under graduate instruction now exceeds six hundred. The value of officers with specialized technical training has been fully proved. Many of the flag officers afloat, heads of technical bureaus, and key subordinates in those bureaus are former Postgraduate School students.

Officers for postgraduate training are selected from applicants of both the Regular Navy and the Naval Reserve who have shown particular aptitude in the various specialties. High standards of admission have been set for guidance in selection. A bachelor of science degree from a recognized educational institution is a prime requisite.

All technical curricula are designed as three-year educational programs to fulfill specific service requirements. In many of these curricula the third year is spent in recognized civilian educational institutions. The following engineering curricula are established at the PG School: Aerological, aeronautical, electronics, ordnance, and naval (marine) engineering. Aeronautical engineering is subdivided so that officers with special qualifications and talents may specialize in power plants, structures, or armaments. Ordnance engineering is further divided into general ordnance, explosives, torpedoes, metallurgy, and fire control. Naval engineering is a broad course embracing both mechanical and electrical engineering. Recently, curricula have been established under naval engineering, in chemical engineering, and petroleum engineering.

In the interests of furthering the Navy's educational program, the Navy Department has granted authority to the Postgraduate School to participate in an exchange-professorship program with selected colleges and universities. The response by civilian educational institutions to this plan assures its being made effective as soon as the country's educational system returns to peacetime schedules.

New War Standard to Protect X-Ray Users

A NEW Safety Code for industrial use of X rays has just been completed by a War Committee of the American Standards Association. This code, drawn up by a committee of the nation's leading experts on industrial roentgenology, with George Singer of the National Bureau of Standards as chairman, is designed to protect workers in the many thousands of plants that are using X rays to further the war effort. The code will also form the basis for a peacetime standard to be developed after the war.

Much of the material in the code is new, having grown out of the research that has been going on since the committee started work in November, 1944, on this job of protecting industrial users of X rays from tissue damage that can lead to permanent disability and even death. Previous to that time standards had been developed by the National Bureau of Standards, particularly for the medical field. These standards can be found in the National Bureau of Standards handbook, "X-Ray Protection," first published in 1931 and revised in 1936.

Technical Societies Council Formed at Kansas City

SEVENTEEN professional and technical societies of the Kansas City area have joined forces in establishing the Technical Societies Council for unified action in matters pertaining to the development of scientific endeavors.

A monthly bulletin will be published programming activities of all organizations. Some of the principal objectives to be advanced immediately include support for establishing better technical and scientific libraries in that region; encouragement of the establishment of educational courses of a technical and scientific nature in the schools of that area and coordination of the vocational-guidance activities of the constituent organizations; and cooperation with civic, educational, and government agencies in matters requiring professional assistance.

At the organization dinner meeting held in Kansas City July 9, Dr. W. M. Hoehn, member of the American Chemical Society and laboratory director of George A. Breon & Co., was elected chairman; C. M. Lytle, Missouri Society of Professional Engineers, with the Kansas City Power & Light Co., vice-chairman; and Charles Briggs, member of The American Society of Mechanical Engineers, with the Burns & McDonnell Engineering Co., secretary-treasurer.

Headquarters of the newly formed Council will be in the offices of the Midwest Research Institute, Kansas City. Miss Sarah C. Lechtman, a member of the Institute's staff, will be manager of publications.

Each of the seventeen organizations elected two delegates to the Council. The organizations are: American Chemical Society, American Institute of Architects, American Meteorological Society, American Institute of Electrical Engineers, American Society of Heating and Ventilating Engineers, The American Society of Mechanical Engineers, American Society for Metals, American Society of Safety Engineers, American Welding Society, Association of Cereal Chemists, Engineers' Club of Kansas City, Illuminating Engineering Society, Institute of Radio Engineers, Midwest Research Institute, Missouri Society of Professional Engineers, American Society of Refrigerating Engineers, and American Society of Civil Engineers.

The representatives of The American Society of Mechanical Engineers on the Technical Societies Council are A. C. Kirkwood and Charles Briggs.

General Motors Announces Proposed Technical Center

ON July 24 Alfred P. Sloan, Jr., chairman of General Motors, announced that as soon as complete clearance on materials and labor could be obtained from government agencies, General Motors Corporation would construct, on a 350-acre site just outside Detroit, Mich., a group of buildings to be known as the General Motors Technical Center which will provide facilities to meet the needs for the Corporation's research, advanced engineering, styling, and processing sections of its general staff activities.

The Technical Center, it was announced, will bring together at one place and at a location physically closer to the manufacturing divisions the research and experimental development facilities of the corporation for the purpose of providing a more rapid interchange of ideas among the technical personnel of the corporation.

The various buildings comprising the General Motors Technical Center will be grouped around a central esplanade within which will be a seven-acre lake which will provide water for cooling the buildings. The administration building will have a frontage of 1000 ft, will provide space for exhibiting the corporation's products, and will incorporate an auditorium seating 1200 persons.

The advanced-engineering building will provide facilities for special product studies, such as car development, car suspension, car structures, transmission development, and engine development.

The research-laboratories building, one of the largest of the group, will house all the facilities now located in a building adjoining the General Motors building in Detroit.

The main floor of the styling section building will be divided into individual design studios measuring 50 × 70 ft, each of which will be fully equipped with facilities to design full-scale models of all projects under development.

The process-development building will provide complete facilities for the study and development of production processes and techniques and the practical application of new techniques to actual production.

The ground floors of all the buildings are to be used for undercover parking space for employees' automobiles. The layout of buildings and roadways throughout the Center will represent the latest ideas in area planning and traffic contro .

H. B. Nottage Joins Staff of A.S.H.V.E.

THE appointment of Herbert B. Nottage, junior member A.S.M.E., as Research Associate on the staff of the Research Laboratory of the American Society of Heating and Ventilating Engineers, at Cleveland, Ohio, became effective July 1 according to the announcement of Prof. G. L. Tuve, chairman of the Committee on Research.

In 1943 and 1944 he was chairman of the A.S.H.&V.E. Technical Advisory Committee on Cooling Towers and has been, for the past three years, secretary of the Heat Transfer Division of The American Society of Mechanical Engineers.

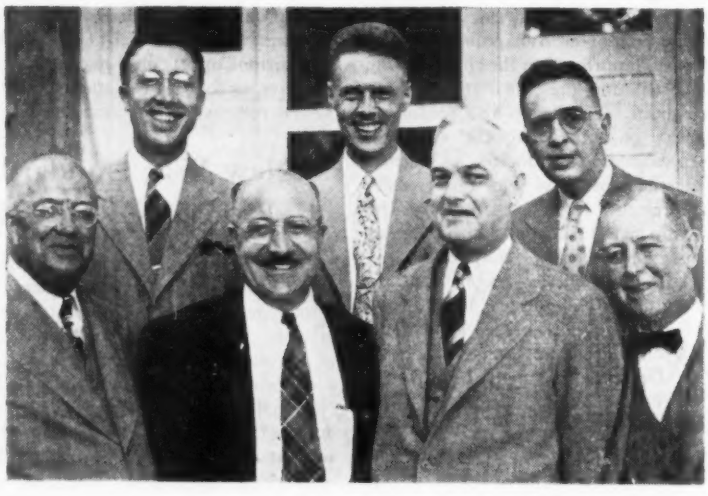
Walters to Be President of Alfred University

ON September 1, 1945, J. E. Walters, member A.S.M.E., takes up his new position as president of Alfred University, Alfred, N. Y.

Rettaliata to Head M.E. Department at I.I.T.

EFFECTIVE Nov. 1, 1945, Dr. J. T. Rettaliata, junior member A.S.M.E., recipient of the A.S.M.E. Junior Award in 1941 and Pi Tau Sigma Medalist in 1942, manager of research and gas-turbine development, Allis-Chalmers Manufacturing Company, will become chairman of the mechanical-engineering department, Illinois Institute of Technology.

Local Sections



AT THE JUNE 22 MEETING OF THE ANTHRACITE-LEHIGH VALLEY SECTION

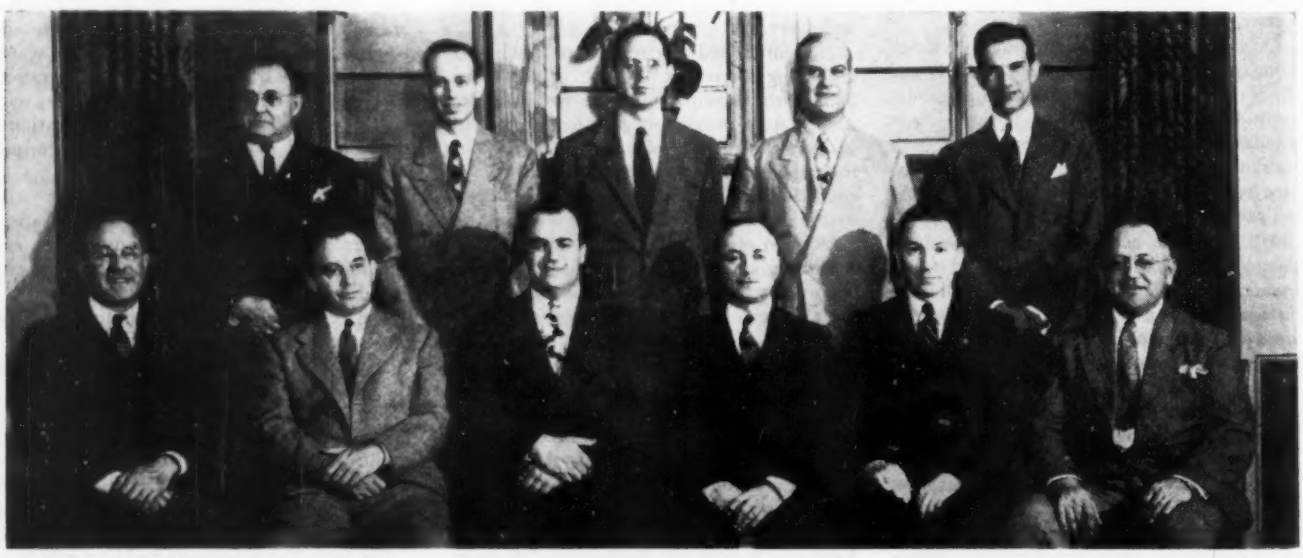
(*Front row:* James Gish, co-chairman of the program committee; C. H. Folmsbee, chairman of the Section; G. A. Stetson, editor of MECHANICAL ENGINEERING and speaker; J. A. Anderson, co-chairman of the program committee. *Back row:* R. W. Morgan, assistant manager of the Allentown district of the Section; K. W. Bliss, secretary-treasurer of the Section; and S. I Hammond, manager of the Allentown district of the Section.)

Chicago Section to Open Season With Stag Smoker, Sept. 28

THE Chicago Section of the A.S.M.E. will open the 1945–1946 season with a stag smoker to be held at the Continental Hotel, 505 N. Michigan Ave., Chicago, on Friday evening, September 28, at 6:00 p.m. This is an annual event of the Section. A buffet supper will be served and the entertainment will include an aquacade, a water show with expert swimmers, as well as other events. The committee also announces "free beer."

Dr. Gilbreth Is Speaker at Tri-Cities Section

"The Engineer's Part in Solving Today's Management Problems" was discussed by Dr. Lillian M. Gilbreth, member A.S.M.E., professor of management at Purdue University, and president of Gilbreth, Inc., Montclair, N. J., at the June 8 meeting at Davenport, Iowa. Dr. Gilbreth covered briefly the effects of the war conversion at the start of this world conflict, and then outlined what the problems might be now that we are converting industry back to peacetime conditions. She made many helpful suggestions for the days ahead.



MILWAUKEE SECTION A.S.M.E., OFFICERS AND DIRECTORS FOR 1945–1946

(*Back row, left to right:* Eric H. Laabs, Max Ruess, treasurer, Robert Cramer, Jr., Theodore A. Wetzel, chairman, and Dr. John T. Rettaliata. *Front row, left to right:* Samuel Gates, Ernest G. Huber, Sebastian Judd, Harold Heywood, secretary, George Miniberger, and Prof. John E. Shoen, Marquette University Student Branch adviser.)

Student Branches

University of Colorado

The first meeting of the summer was held by this Branch on August 2. The following officers were elected: chairman, Donald G. McPherson; vice-chairman, John A. Kelly; secretary, Louis M. Kulr; treasurer, Clyde W. Sissman. Committees were appointed and arrangements made for a smoker and get-together.

Cooper Union Branch

At the last meeting of the spring term, held on April 20 at the Hewitt Building, several students presented short papers on various features of gas turbines. These were read in conjunction with a film on the same topic, and had been prepared in order to show more clearly the operation and the advantages of the gas turbine.

Illinois Institute of Technology

Students of the Institute were privileged to attend on June 8 and 9 a splendid demonstration and lecture, with equipment valued at $20,000, given by the Studebaker Corporation under the auspices of the Illinois Institute of Technology Student Branch of the A.S.M.E. The speaker, Mr. Perkey, sales engineer for the company, included in his talk the elementary design principles, manufacture, and testing of the B-17 Flying Fortress engine, developing 1250 hp. Mr. Perkey was aided by an automatic poster displayer, a cutaway of the Wright cyclone engine. The demonstration was repeated four times in the two days and about 200 were in attendance at each session. A discussion period followed each lecture when questions were answered and a close-up examination permitted of the slowly turning engine.

On June 13 members of the Branch met to elect officers. Results were: Norman Spector, chairman; Leonard Jatczak, vice-chairman; Joseph Vieceli, secretary; and Jack Schmidt, treasurer.

The first meeting of the semester was held by this Branch on July 27 when the chairman, Norman Spector, pointed out the advantages of A.S.M.E. student membership to the newcomers. The honorary chairman of the Branch, Dr. Budenholzer, was introduced and amplified Mr. Spector's remarks concerning the A.S.M.E. Mr. Hadley from Armour Research Foundation then gave an interesting demonstration of the Armour magnetic-wire sound recorder, having musical selections played for a comparison between disk and wire records, the latter needing no needles, having continuous recording, high fidelity, compactness, and infinite use of the wire.

Iowa State College Branch

At the meeting on June 13 in the Engineering Assembly, David L. Arm, head of the mechanical-engineering department, introduced Lieut. Jack McLocklin, a bomber pilot, son of Superintendent McLocklin of the Iowa Power and Light Company, Des Moines, Iowa.

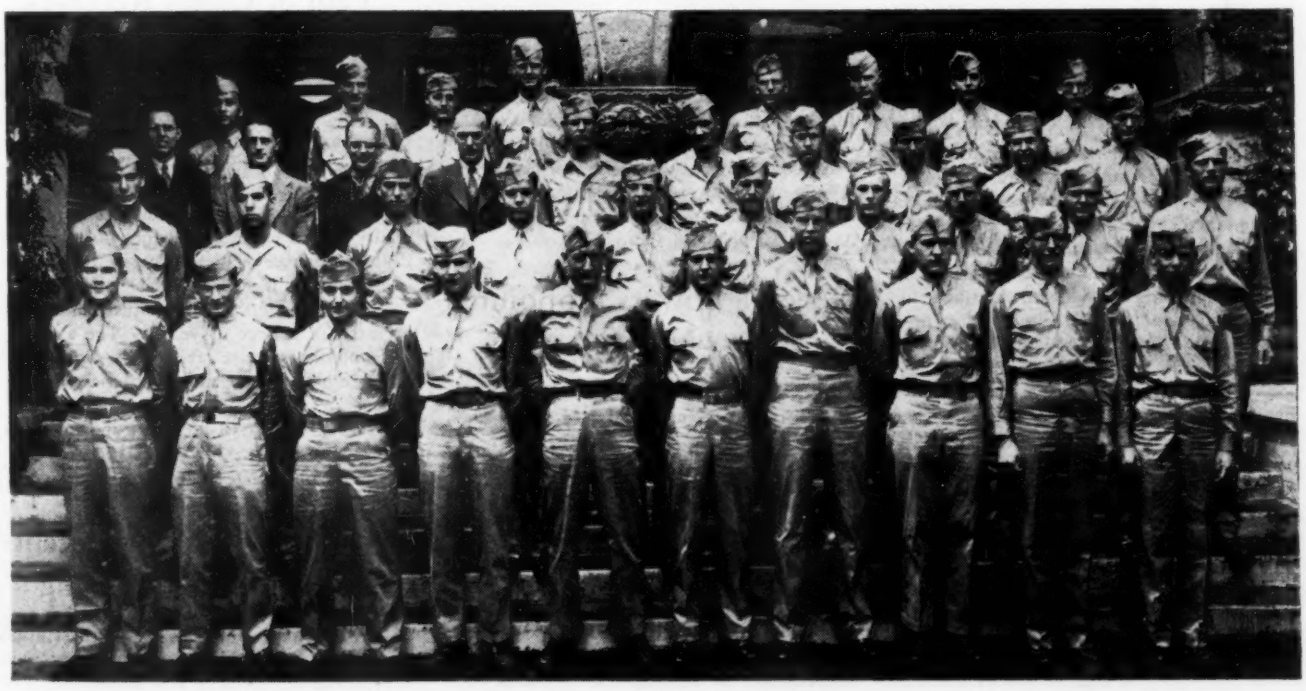
The elder McLocklin then gave a brief survey of the growth of the power plant and equipment at Des Moines, illustrating his talk with slides. Problems occurring during the growth of the plant were discussed and solutions given. A discussion period followed in which questions were answered by Mr. McLocklin and Mr. Beatty, the latter, power-transmission expert of the Des Moines plant. Election of officers followed: Steven Shea, president; Warren Lundsgaard, vice-president; H. J. Stoever, faculty adviser; Tom Acker, treasurer; and Bill Dace, secretary.

University of New Mexico Branch

Three meetings were held in May, the first one on May 1, when plans for the Engineers' Carnival were discussed. Al Hazard presented a paper on "Helicopters." The second meeting on May 7 featured a paper by Harry E. Kenney entitled "Engineer on a Destroyer." On May 21 Bob Blaise gave a paper on "Surveying Instruments." It was announced that Ruth Ford Kendrick had won first prize and Al Hazard second prize for their papers.

On July 17 a short business meeting was held to discuss plans for the softball game between the Engineering and Arts and Sciences Colleges, to be held July 28. Tentative plans were also made for an initiation of all freshmen engineers, and an engineers' picnic and dance, to be held September 1.

On July 24 a combined meeting of all of the engineering societies at the University of Mexico was held at which Marvin Goldberg, president of the Engineering Council, presided. After a short business meeting, the speaker of the evening was introduced—Capt. John Carey, U. S. Army, Corps of Engineers. Captain Carey, who had spent 25 months in the China-Burma-India theater, spoke on his experience in the construction of the Lido Road in Burma, explaining the influences of the different religious groups on the construction problems. He was in charge of all electrical work and later was post engineer so his problems were many—scarcity of supplies, disease, shortage of skilled labor, along with the natural difficulties of the terrain.



OREGON STATE COLLEGE STUDENT BRANCH OF THE A.S.M.E.

(*In the third row from the front, left to right are:* C. A. Arents, honorary chairman of the Branch, R. L. Richardson, instructor in mechanical engineering, W. C. Baker, assistant professor of mechanical engineering, and Prof. S. H. Graf, a manager of the A.S.M.E.)

Oregon State College Branch

A short business meeting of the Branch was held on July 17, 1945, at which time there was an election of officers for the summer term. A general program was outlined for the term which included three inspection trips and a Branch meeting for the first and third Tuesdays of each month. Activities for the past term were reviewed with much interest. They included semimonthly meetings and inspection trips to the Cascades Plylock Corporation, the municipal-owned steam and hydroelectric plants of Eugene, Oregon, and a weekend pleasure trip to the Oregon beaches. The membership were enthusiastic in expressing their approval of the Branch activities.

The Pennsylvania State College

The first meeting of the semester was held by this Branch on July 26 and was designed to acquaint the incoming freshman in the mechanical and aeronautical courses with the general organization and purposes of the A.S.M.E. Plans were made for future meetings where short discussions are to be given on new developments.

Polytechnic Institute of Brooklyn Branch

The evening session of the Branch held a meeting on May 3 when the speaker was Dr. D. B. Steinman, international authority on bridge design. His talk, entitled "Disaster of the Tacoma Narrows Bridge," was illustrated with motion pictures and scale models. Dr. Steinman told of the construction of the bridge, the third largest in the world, which was completed in July, 1940, and how, four months after it was opened to the public, the oscillation of the bridge in a gale increased to destructive amplitude until the main span tore loose from the main cables and plunged into the waters below. He indicated by the scale models how easy it would have been to save the bridge from destruction by suspending a disk from a cable into the water, thus decreasing the aerodynamic instability.

On May 17 the last meeting for the summer was held. Plans were made for next term's activities. As Rudy P. Luttkus, the former treasurer, had left to join the Navy, J. E. McGillen was unanimously elected to succeed him. Several new members were accepted.

On July 10, 1945, thirteen members of the Evening Student Branch at the Polytechnic Institute of Brooklyn visited the Jacob Ruppert Brewery plant in New York City. The tour, arranged by Irving Handelman, chairman, and personally conducted by J. Gordon Morrow, a Poly alumnus, started at 7:30 in the evening.

The brewery, which covers the major portion of four large city blocks, seems even more immense inside than it looks from the outside. The tour started with an inspection of the modern bottling facilities and took in the keg washhouse, racking room, the fermentation and storage tanks, cooking kettles, mash tubs, filter rooms, and power plant. Quite interesting were the cold-storage rooms where an overcoat could have been used to advantage; in other rooms a tiger skin would have come in quite handy. One of the main compressors furnishing power for the cold-storage facilities, it was interesting to note, is over two stories tall, with a flywheel over 15 ft in diameter. While there is quite a lot to the brewing process and associated equipment, the narration by Mr. Morrow did much to clarify the process. By far, one of the most noteworthy facts of the entire trip was the cleanliness and neatness of the departments inspected.

University of Southern California Branch

The first meeting of the summer term was held on July 11 at Harris Hall auditorium when the new president, J. R. Nash, presided. The speaker was J. Calvin Brown, member A.S.M.E. and past chairman of the Los Angeles Section, whose subject was "The Advantage of Student Membership in the A.S.M.E." Mr. Brown, is a vice-presidential nominee of the A.S.M.E. for 1946.

University of Virginia Branch

At the first meeting of the summer term on July 10, at Thornton Hall, a new treasurer, Chas. W. Mohr, was unanimously elected to serve the unexpired term of the former treasurer who was called to military service. A membership committee was appointed for the purpose of increasing the active membership. A program committee was also appointed, and arrangements were begun for a joint meeting of all the engineering societies at the University on August 10.

A.S.H.V.E. Establishes Allen Memorial Library

THE establishment of the John R. Allen Memorial Library by the American Society of Heating and Ventilating Engineers has just been announced. It is planned that this Library of books, pamphlets, and other printed matter dealing with the arts and sciences of heating, ventilating, and air conditioning will be located in the Society's Research Laboratory. Authors of textbooks and reference books are invited to contribute gift copies, and members and friends of the society are urged to send textbooks and any other printed material of historical value to this newly created library. A special bookplate has been prepared and will be placed in each volume in the Library and all contributed volumes will bear the name of the donor.

All contributions should be sent parcel post or express collect to the Director of Research, A.S.H.V.E. Research Laboratory, 10700 Euclid Avenue, Cleveland 6, Ohio.

General Powers Appointed to N.A.C.A.

APPOINTMENT by President Truman of Brigadier General Edward M. Powers, Assistant Chief of Air Staff, Materiel and Services, Army Air Forces, to membership on the National Advisory Committee for Aeronautics has been announced by Dr. Jerome C. Hunsaker, N.A.C.A. Chairman today.

General Powers assumes the place on the Committee recently vacated by Major General Oliver P. Echols upon the latter's assignment to duty overseas.

The Committee is devoted to the scientific investigation of aeronautical problems. Its research facilities at Langley Field, Va., Cleveland, Ohio, and Moffett Field, Calif., provide the basic research data which the military services and the private aviation industry are applying to maintain America's aviation supremacy.

Lamme Medal Awarded to H. P. Hammond by S.P.E.E.

THE 1945 award of the Lamme Medal of the Society for the Promotion of Engineering Education was made to H. P. Hammond, member A.S.M.E., dean of engineering, The Pennsylvania State College.

The medal is awarded annually under the terms of the will of the late Benjamin G. Lamme, formerly chief engineer of the Westinghouse Electric Corporation, for "accomplishment in technical teaching or actual advancement in the art of technical training."

The citation which accompanied the award to Dean Hammond reads: "To Harry Parker Hammond, for his lifelong devotion to the advancement of engineering education, his vision of its responsibilities, his wisdom in plotting its course, and his skill in crystallizing the wisdom of others; for the clarity and force of his language in stating its methods and philosophy; for his ability as teacher and administrator, in carrying out its great ideals and in giving to students his own high sense of their calling."

E.C.P.D. to Meet Oct. 19–20 in New York

THE thirteenth annual meeting of the Engineers' Council for Professional Development will be held in the Engineering Societies Building, New York, N. Y., on October 19 and 20.

Paul S. Clapp Receives Anson Marston Medal

PAUL S. CLAPP, vice-president of the Columbia Gas and Electric Corporation, Columbus, Ohio, received the Anson Marston Medal at the graduation exercises of Iowa State College, Ames, Ia., on June 15.

Award of the Marston Medal is made annually to the engineer alumnus of Iowa State College "whose achievement in the professional world has been such that it merits special recognition." The recipient must have been out of college 25 years. The award is based on the graduate's record as a professional man, administrator, and his participation in civic affairs and research.

W. L. Abbott, past-president and honorary member, A.S.M.E., represents the A.S.M.E. on the Anson Marston Medal board of award.

To Publish Lists of Patents Available for Licensing

COMMENCING June 1, 1945, the United States Patent Office put in operation a new service to industry and inventors. The purpose of the service is to bring to the attention of the nation patented inventions under which the owners are willing to grant licenses on reasonable terms. It is hoped that such

information will lead to greater employment opportunities in the reconversion period, as well as permit industry to become acquainted with what is being done in various fields.

To accomplish these purposes, a Register of Patents Available for Licensing is now being established and will be maintained in the United States Patent Office. Patents recorded on this register will be available to the public for inspection in Washington, D. C. Lists of such patents will be published in the Official Gazette of the Patent Office.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient, nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the NewYork office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Boston, Mass.	Chicago	Detroit	San Francisco
8 West 40th St.	4 Park St.	212 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE [1]

MECHANICAL ENGINEER, graduate, age 32, married, excellent health. Past four years project engineer involving development of small mechanisms and extensive contacting of manufacturers. Previous sales-engineering experience. Desires permanent, responsible position. Me-924.

PRODUCTION ENGINEER, age 30, graduate and licensed mechanical engineer, experienced in supervision of manufacturing layouts, all phases of industrial and management engineering, material handling, equipment design, power-plant operation. Location, East or Middle West. Me-925.

POSITIONS AVAILABLE

CHIEF ENGINEER. Must be experienced in complete design of boilers of all types. $7500–$8000 year. New Jersey. W-5715.

WORKS PLANT MANAGER, 35–40, for small manufacturing concern in metal-processing field. Should have experience in production control, costs, and manufacturing operations, in either the ferrous or nonferrous fabrication field. $6000–$6500 year. Massachusetts. W-5717.

GENERAL SUPERINTENDENT, to 45, capable of supervising paper-bag making and printing operations of multibranch concern. Multiwall and single-wall shipping containers of plain kraft and coated papers. Considerable traveling. $4000–$4500 year plus traveling expenses. Headquarters, New York, N. Y. W-5722.

PAPER-MILL SPECIALIST to dismantle, crate, and ship cardboard paper mill, after which he will set up and operate it as general superintendent. Salary open. Brazil. W-5726.

[1] All men listed hold some form of A.S.M.E. membership.

DEVELOPMENT ENGINEER, 35–45, mechanical graduate or equivalent, with experience in designing and direct development of small mechanical devices. Must have creative ability. Knowledge of plastics desirable. Company engaged in mass production of light metal novelties. Salary open. Northern New Jersey. W-5732.

SALES ENGINEER AND CONTACT MAN with good connections with management in oil-refinery trade, to take charge of New York office for company manufacturing welded iron tanks. $7500–$10,000 year. W-5745.

ENGINEERS who have majored in marketing, preferably retailing, to assist in developing sales-training programs. (*a*) Engineer to do research and developmental work with ability to organize training material and for editorial work. Experience in visual aids would be desirable. (*b*) Engineer with experience in sales training to serve in capacity of assistant to head of sales training section. Considerable time will be spent in conferring with sales managers and sales engineers. (*c*) Engineer preferably specialized in electrical engineering and with some personnel experience, for college recruiting section. Good personality and able to work with university officials and department heads in plants. New Jersey. W-5765.

CHIEF ENGINEER, 35–50, with experience designing special machines, preferably in diversified fields. Must be able to go out, design, and build a special machine for a particular industry, discuss the various angles of operation with superintendent of plant, obtain all data necessary to proceed with design intelligently. $7500–$9000 year. Connecticut. W-5769.

ENGINEERS. (*a*) Plant manager for large company engaged in electromechanical industry for plant employing some 1500 people. Any experience in electronics desirable. $8000–$10,000 a year. (*b*) Production manager particularly experienced in production control in large electromechanical manufacturing industry. $6500 year. (*c*) Industrial engineer with several years' previous experience in electronics or related fields in industrial-engineering problems, to set up or revise as necessary systems to control flow of work, materials, and allocation of manpower to make for efficient production. Set up work standards, methods of procedure, and proper inventory controls to minimize delays in production. Salary to $6500 a year. Massachusetts. W-5771.

SUPERINTENDENT, 35 or older, with at least five years' progressive recent experience in charge of plant and production of batteries; experience and knowledge necessary in manufacture of dry cells for commercial and household use. Opportunity with established important producer of wet and dry batteries as plant and production manager. Plant to be furnished with latest equipment. Contract for three years, with renewal, at minimum salary of $10,000 year or more, depending upon agreement. India, W-5784.

INDUSTRIAL ENGINEERS. (*a*) Industrial engineer, 35–45, to direct and co-ordinate all engineering work, including methods, layout, motion and time study, wage-incentive plan application. Develop and minister cost reduction program, train personnel, and build effective plant departments. Company manufactures wearing apparel. Some traveling to various plants. $10,000 year. East central New York. (*b*) Industrial engineer, not over 40, to work on special assignments for radio division of large company. Will be required to co-ordinate equipment-development programs and assist in defining plant organization. Devising control methods and procedures and install programs. $6000 year. New York State. W-5799.

MECHANICAL ENGINEERS, 25–45, good at drawing and in reading blue prints. Will do some traveling to branch plants when installing and designing equipment and machinery. (*a*) One experienced in power-plant installations and maintenance. (*b*) The other experienced in materials handling and control. Missouri. W-5804-C.

ENGINEER for company employing 1800 people and having large toolroom. Will consider either young engineer with some tool experience or more experienced man to supervise toolroom and drill-press room. Should have good engineering background and be qualified to lay out and plan tools and have knowledge of equipment. Some design experience desirable. Company manufactures novelty jewelry. Salary open, depending upon background and experience. Permanent. New England. Interviews, New York, N. Y. W-5808.

CHIEF DRAFTSMAN with mechanical design background. Experience with hydraulic machinery or pumps desirable. Permanent position with long-established pump manufacturer. Salary open. Indiana. W-5824-C.

ENGINEER, 30–40, mechanical training, to act as assistant to chief engineer. Work involves improving production methods and making time studies. Should be familiar with modern machine tools and jig design. Salary commensurate with experience. Postwar opportunity. Upstate New York. W-5830.

ADVERTISING MANAGER, mechanical-engineering graduate or equivalent, with several years' experience in the preparation of advertising and sales promotion material for manufacturer of industrial equipment. Any experience in the use or sale of industrial equipment, such as turbines, gears, and pumps, would be helpful. $5000–$7000 a year. New York, N. Y. W-5839.

CHIEF ENGINEER, 35–45, with experience in executive and administrative end of engineering. Should also have some experience in field of light metals, either in aircraft or related industries. Will have supervision over design and drafting, research, development, testing, as well as quality control in factory. Will be in charge of 150 employees. $7000–$8000 year. Connecticut. W-5842.

MECHANICAL ENGINEER, not over 32, graduated in top third of his class. Should have at least five years of practical experience, especially in connection with small machine-shop work, some design work, production planning, and mechanical product development. Will take over research and development program; also purchasing of mechanical parts for textile mill; will confer with suppliers with reference to parts to be ordered and do general product development work. $4500–$5000 year. Permanent, excellent opportunity. New England. W-5852.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after September 25, 1945, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ALLEN, LYMAN H., JR., Marcus Hook, Pa.
ALLEN, WILLIAM B., Knoxville, Tenn.
BATSON, J. E., Buffalo, N. Y.
BELCHER, W. DEANE, Ettrick, Va.
BELLETTI, JOHN, Philadelphia, Pa.
BLADEN, ARTHUR MCK., Chicago, Ill.
BOALS, ROY L., Schenectady, N. Y.
BOWMAN, WILLIAM D., Philadelphia, Pa.
BURKE, HENRY, St. Louis, Mo.
CAYWOOD, C. M., Fremont, Mich.
CHAPLIN, ALLEN L., New York, N. Y.
CLARKE, H. G., Durban, South Africa
COBB, D. B., JR., Greensboro, N. C.
CONLEY, WILLIAM J., Cleveland, Ohio (Rt & T)
COSTELLO, J. R., Easton, Pa.
CUOZZO, DANTE, Charlestown, Mass.
DANSON, JOHN O., Chicago, Ill.
DEANE, DISQUE DEE (LIEUT. COMDR.), Hewlett, N. Y.
DOWDING, LEONARD F., New York, N. Y.
DRAKE, JOHN L., Washington, D. C.
EVES, I. GENE C., Melrose Park, Ill.
FAGIN, SIDNEY, New York, N. Y.
FENG, TZE PEI, Washington, D. C.
FULLER, ANDREW L. (ENSIGN), c/o F. P. O., San Francisco, Calif.
FUNK, EUGENE D., Wickliffe, Ohio
GADDIS, PRESTON G. (LIEUT. COMDR.), Washington, D. C.
GARNER, WILFRED JAMES (LIEUT. COMDR.), Holyoke, Mass.
GERHARD, SIDNEY, Brooklyn, N. Y.
GIDDENS, E. T., Wellington, N. Z.
GOODIN, ALBERT B., Los Angeles, Calif.
GREENFIELD, HORACE D., Pittsford, N. Y. (Rt & T)
HARTHORN, PAUL DUDLEY, San Francisco, Calif.
HENDERSON, CLAUDE E., Staten Island, N. Y.
HORSLEY, SHERMAN, Independence, Mo.
KAVAN, P. D., Jamshedpur, India
LANG, WILLIAM A., Philadelphia, Pa.
LEWIS, ROBERT C., New Haven, Conn.
LI CALSI, JOSEPH, New York, N. Y.
LOBSTEIN, ROBERT, Chicago, Ill.
LYNN, STANLEY, Palo Alto, Calif.
MARSHACK, EUGENE, New York, N. Y.
MAZZA, CHARLES A., East Lynn, Mass.
MAZZOLA, AMBROSE, Southgate, Calif.
MCDONNELL, WILLIAM P., Hollidaysburg, Pa.
MCKITTRICK, WILLIAM K., Bayville, N. Y.
MEAGHER, R. D., Toronto, Ontario
MEYERDICK, CLARENCE E., Fair Oaks, Calif.
NANDY, D. P. (CAPT.), India
NEITHERCUT, DONALD C., Denver, Colo.
NILSEN, LORNTS BERNARD, Wenham, Mass.
NODELYK, JOHN C., Alton, Ill.
OHMAN, THORWALD, Chicago, Ill.
PAWELCZYK, JOSEPH ANTHONY, Schenectady, N. Y.
RANKIN, CHARLES J. (MAJOR), Montreal, Quebec
REUTER, P. T., Boston, Mass. (Rt)
REYNOLDS, HERMAN F., Collingswood, N. J.
REYNOLDS, JAMES I., Morgantown, W. Va. (Rt & T)
RICARD, P. J., New York, N. Y.
RIMBACH, RICHARD, Pittsburgh, Pa.
RISE, KAARE, St. Paul, Minn.
ROBERTS, RALPH T., New York, N. Y.
ROBINSON, HOWARD A., Lancaster, Pa.
SCHAPER, HARRY C., Alton, Ill.
SCHEER, LLOYD F., Alexandria, Va.
SOPER, CLEVELAND C., Kent, Ohio
SOPRIS, ROBLEY F., Glendale, Calif.
SORENSEN, KRESTEN T., Media, Pa.
SPERLING, ERICH, Islip, N. Y.
THORNTON, JNO. A., Huddersfield, England
VAN DYCK, W. C., Peoria, Ill.
WAGNER, HARRY D., Philadelphia, Pa.
WAIBLER, PAUL J., New Haven, Conn.
WALTERS, R. J., Detroit, Mich. (Rt & T)
WICKSTROM, HAROLD W., Los Angeles, Calif.
WILLEY, CALVIN MCAULEY, Pittsburgh, Pa.
WILLIAMS, GEORGE DAVID, Marlboro, Mass.
YOUNG, CHARLES F., Philadelphia, Pa.

CHANGE OF GRADING

Transfers to Member

ANTONY, CHARLES, JR., Rockville Centre, N. Y.
BECKER, CHARLES S., La Grange, Ill.
BEDINGER, ALBERT F. G., Knoxville, Tenn.
BENNETT, WILLIAM C. M., East Liberty, Pa.
BENOIT, LESTER W., Reading, Pa.
BILLHARDT, F. A., New York, N. Y.
CANNON, C. NEWTON, Swampscott, Mass.
COOPER, HOWARD, New York, N. Y.
FISCHMAN, SAMUEL O., Chicago, Ill.
GREINER, J. C., Toledo, Ohio
HENNIG, FRITZ O., Greensburg, Pa.
LANDIS, WARREN C. (MAJOR), Arlington, Va.
LEUTWILER, R. W., JR., West Lafayette, Ind.
LEWIS, HERBERT F. (MAJOR), Arlington, Va.
OLIVE, THEODORE R., New York, N. Y.
RATHE, ALEX W., Ampere, N. J.
SCHOLTZ, HERMAN J., Butler, Pa.

Transfers from Student Member to Junior..100

Necrology

THE deaths of the following members have recently been reported to headquarters:

BRADY, HUGH S., January 13, 1945*
BRANDIN, WILLIAM H., April 18, 1945
DAVIDSON, MORGAN W., April 11, 1945
DELANY, CHARLES H., November 24, 1944
HALL, ROLAND B., January 26, 1945
HOPPES, JOHN J., July 12, 1945
JOHNSON, ERNEST M., July 18, 1945
POPP, GEORGE T., December 20, 1944
ROBINSON, C. SNELLING, July 22, 1945
SPRAGUE, BENJAMIN O., January, 1944
WEIR, THOMAS A., April 28, 1945
WOOLFSON, HARRIS D., April 29, 1945

A.S.M.E. Transactions for August, 1945

THE August, 1945 issue of the Transactions of the A.S.M.E. contains:

Use of Anthracite Fines in By-Product Coke Production, by J. D. Clendenin, K. M. Barclay, and C. C. Wright
Blending Coals Reflects Greater Uniformity of Product, by R. F. Stilwell
Ignition Through Fuels Beds on Traveling- or Chain-Grate Stokers, by E. P. Carman and W. T. Reid
Prediction of Centrifugal-Pump Performance, by R. J. S. Pigott
A Study of the Theory of Axial-Flow Pumps, G. F. Wislicenus
Optimum Compression Ratios for a High-Speed Diesel Engine, by W. P. Green
Elastic Properties of Plastic Materials, by John Delmonte
Presentation of Centrifugal-Compressor Performance in Terms of Nondimensional Relationships, by B. E. Del Mar
A Pneumatic Piston-Ring Gage for Radial-Pressure Measurement, by P. G. Exline
Application of Controlled Atmospheres to the Processing of Metals, by C. E. Peck

* Died in line of duty.

• Keep Informed . . .

Announcements in this section are supplied by current advertisers in MECHANICAL ENGINEERING and A.S.M.E. MECHANICAL CATALOG.

This section is restricted to these advertisers.

• NEW EQUIPMENT
• BUSINESS CHANGES
• LATEST CATALOGS

Available literature may be secured by addressing a request to the Advertising Department of MECHANICAL ENGINEERING or by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• NEW EQUIPMENT

"Unbrako" Key Kit

Recognizing the need for one tool to take the place of separate screw drivers or wrenches for each one of the many screw heads in general use today, the Standard Pressed Steel Co. of Jenkintown, Pa., has devised an ingenious "all in one" screw driver.

Under the name "Unbrako" Key Kit, this tool, for which a patent has been applied, is being manufactured. The Kit, publicized through current trade paper advertising and by means of a three-color four-page folder illustrated with full size photographs, is available in two sizes, both of which are identical in design.

The tool, which resembles a screw driver in appearance, has a hollow indestructible handle of transparent plastic composition, forming a receptacle for the nine keys or bits which comprise the Kit.

The keys, which fit all socket head, Phillips head or slotted screws, are inserted in a chuck in lower part of handle and used in vertical position, or for use in ordinarily inaccessible locations, may be inserted in socket at right angles to handle.

New Silicone Valve Lubricant

Merco Nordstrom Valve Co. is now the exclusive distributor of a new valve lubricant which possesses unusual properties advantageous for a number of severe services.

This lubricant is colorless and one of its outstanding properties is that its viscosity changes only slightly over a very wide temperature range. It is recommended for working temperatures ranging from 40°F to 400°F. Due to its extremely low vapor pressure, it does not evaporate appreciably even at elevated temperatures.

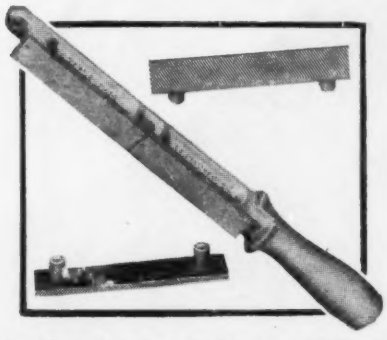
Its principal services are steam, hot water, hot air, oxygen, high vacuum, also for dilute solutions of mineral acids (except nitric and hydrofluoric acid below 250°F); hydrochloric acid, natural and synthetic rubbers, acetic acid, acetic anhydride and ethyl alcohol below 250°F.

It is available only in soft bulk form for application by grease guns.

Further details may be obtained from Merco Nordstrom Valve Co., 400 Lexington Ave., Pittsburgh 8, Pa.

New Lathe File

Kennametal Inc., Latrobe, Pa., announces the development of a new lathe file that retains the advantages of previous models in that it will cut steels no ordinary file will touch, at speeds 3 to 10 times faster than possible with steel files, with a life of 50 to 200 times as long, and in addition provides longer filing surface, quick, easy blade replacement, and greater handling convenience.

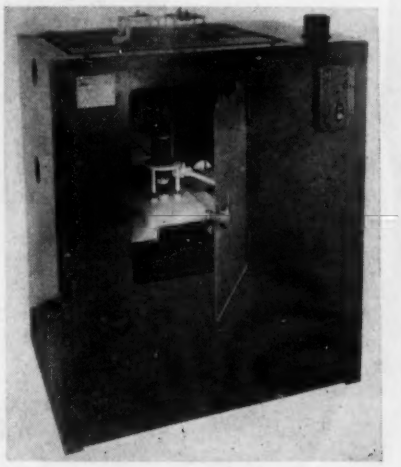


In this new design, the Kennametal blanks have brazed-on nuts, as shown in the insets on the illustration, and are attached to the light-weight aluminum alloy handle by screws. They can therefore be readily replaced when worn, from long service. Two types of blanks—fine (30 teeth per inch) and coarse (20 teeth per inch) are available, and are interchangeable on the same handle. The handle grip is shaped to fit the hand, and has a thumb rest and knuckle guard. An extension beyond the filing surface supplies a convenient finger hold. A hole in this extension permits the file to be hung up.

One size is now available—the F-45, $13\frac{1}{2}$" long overall—with a filing surface $\frac{3}{4}$" wide × 8" long, comprising two $\frac{3}{4}$ × 4" Kennametal blanks. Notwithstanding its new and distinctive features, this file is available at the same price as the previous model.

New Small Universal Testing Machine

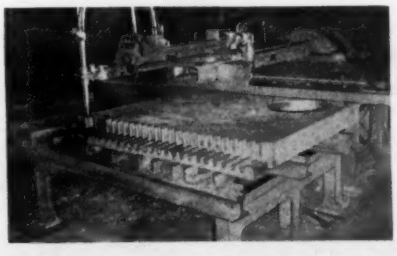
The importance of plastics, plywood and lighter sheet metals in postwar industry has led to the development and production by the Southwark Div. of the Baldwin Locomotive Works of a small machine for testing these materials. Since this machine, with an alternating force capacity of one-hundred pounds, also is ideal for testing structural components and machine parts in both repeated bending and repeated torsion, it is truly a universal machine. This one machine should solve the problems that are facing test engineers in many industries.



An outstanding feature of the machine permits any predetermined alternating load to be kept automatically constant regardless of the changes of deflection that may occur in the specimen under test. The one-hundred pound capacity of the machine can be adjusted in increments of .2 of a pound. Its speed is 1800 load cycles per minute and has a maximum capacity in bending of 200 inch pounds and in torsion of 1125 inch pounds.

This universal fatigue testing machine will test plastics up to a thickness of one-half inch, aluminum alloys of three-sixteenths of an inch, and steel of approximately one-eighth of an inch. There is ample space for testing bulky assemblies and it is adjusted easily for various specimen sizes. Numerous tapped holes and T-slots in the platens will accommodate special fixtures. The machine is seismically suspended in the frame to eliminate vibration to the floor.

Flame-Cut Cinder Car Rack



By using an oxy-acetylene shape-cutting machine, a Midwestern steel plant recently saved more than 50 per cent of the cost of a

Continued on Page 29

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company

500 Fifth Avenue • New York City

MOLY

• Keep Informed

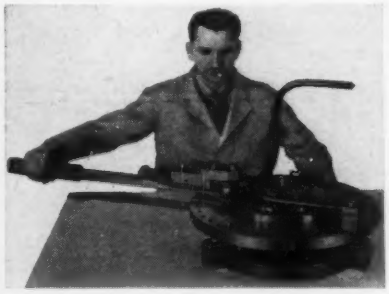
new piece of equipment. This plant needed a replacement for a cinder car rack, a structure 5 ft. by 4 in. by 2-1/4 in., used to hold the cinder car while it is being tipped to discharge its molten slag. The original rack had been cast. To avoid the high cost and lengthy delay that would be involved in making a pattern and mold for the single replacement, it was decided to flame-cut the part from a 5 in. thick steel slab with an Oxweld CM-12 shape-cutting machine.

Since only a limited number of the racks were to be cut, a templet for guiding the cutting machine was sawed out of 1/4-in. composition board instead of using the standard aluminum templet strip. This faster, cheaper method was entirely satisfactory for this application because the templet was used only a few times.

Total cost for material and cutting for each rack was estimated at $18.30 as compared with $40.00, the estimated cost of a new cast part. Flame-cutting was sufficiently accurate so that no machining of the part was necessary. A further saving is realized by this steel plant since it is now unnecessary to stock these racks as replacements or wait for delivery when needed.

"Di-Acro" Bender

Several years ago MECHANICAL ENGINEERING carried publicity concerning the original "Di-Acro" Bender, a basic product of O'Neil-Irwin Mfg. Co., Minneapolis 15, Minn.



Now they have just completed the first production run of three entirely new "Di-Acro" Bender models, which have been thoroughly redesigned and re-engineered and incorporate several major changes and improvements over the original models.

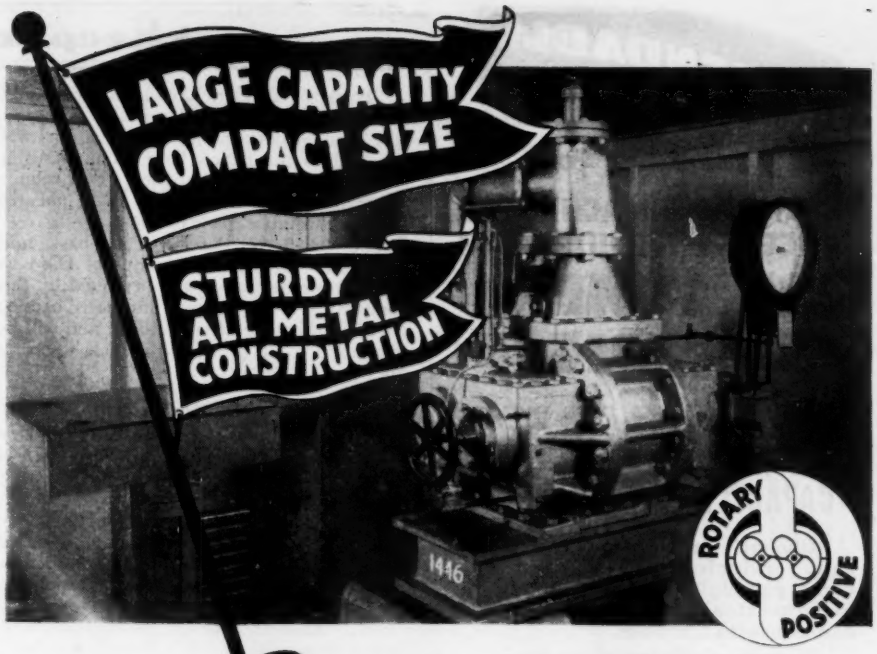
Operating friction has been greatly reduced in these new Benders by the installation of Torrington Roller Bearings which increases the ease of operation approximately 35% and adds considerable forming capacity to these precision units.

Another prominent new feature of the No. 2 and No. 3 size "Di-Acro" benders is the instantly reversible lever control cam, which allows the operator a choice of either right or left hand forming direction. Interference, which may develop when forming several intricate shapes successively in a single piece, can be quickly eliminated through this two way operating feature by simply reversing the forming direction of the machine.

Illustration shows Di-Acro Bender accurately forming tubing, without inside supporting mandrels, and a centered eye or light weight pipe support.

All Di-Acro Benders are highly versatile and universal machines that can be arranged right on the job for all types of forming in a ductile materials including round, half round, square and hexagon rod, tubing, angle, channel, moulding strip stock and bus bar (formed both flat or edgewise).

Continued on Page 30



Permanent ACCURACY

This Installation
30,000 C.F. Hr.
125 lbs. Pressure

For measuring the production and use of both natural and manufactured gases, Roots-Connersville Rotary Positive Displacement Meters assure extreme accuracy of measurement. Furthermore, this accuracy is *continued* for their entire life.

This is because there are no light metal parts or diaphragms to wear or deteriorate, and destroy the accuracy of measurement. "R-C" Meters have rugged all-metal construction throughout. In addition to assuring sustained accuracy, their simple all-metal construction gives "R-C" meters unimpaired usefulness far beyond that obtained from other types of meters.

Other advantages are:

1. Accuracy maintained despite changes in specific gravity, or temperature.
2. Large capacity combined with compact size.
3. Negligible power absorption.
4. Metering accuracy is tamper-proof.

The longer life, minimum attention and maintenance requirements, and greater accuracy of "R-C" Meters repay their cost many times over.

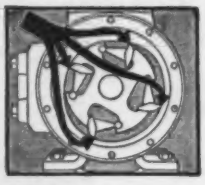
ROOTS-CONNERSVILLE BLOWER CORP.
ONE OF THE DRESSER INDUSTRIES
509 MICHIGAN AVENUE CONNERSVILLE, INDIANA

Roots CONNERSVILLE SINCE 1854

WRITE FOR BULLETIN 40-B-13

Rotary Positive GAS METERS

DEPENDABLE PUMPS for
DEPENDABLE MACHINES & PROCESSING EQUIPMENT
BLACKMER ROTARIES
are
SELF-ADJUSTING FOR WEAR
SUSTAINED CAPACITY



"Bucket" design (swinging vane principle) automatically compensates for wear.

20 years of service is not unusual for a Blackmer pump.

WRITE NOW FOR
Bulletin No. 306—Facts about Rotary Pumps
Bulletin No. 302—Pump Engineering Data

BLACKMER PUMP COMPANY
1920 Century Ave. Grand Rapids 9, Mich.
Capacities to 750 GPM Pressures to 500 psi

POWER PUMPS • HAND PUMPS • EZY-KLEEN STRAINERS

• Keep Informed . . .

"Di-Acro" Benders have been widely used for the production of all types of War Supplies and Munitions and are equally as well adapted to the Peace Time Manufacturing of all products and components that require accurately formed and precisely duplicated parts within their construction.

The "Di-Acro" Bender is the basic unit in the new industrial technique of Die-Less Duplicating developed and perfected by this company. A 40-page well illustrated catalog covering this subject is available and will be forwarded to all interested readers upon request.

Propeller-type Meter for Hot Water

Widely used for metering water at ordinary temperatures, Builders Propeloflo Meter is now available at no extra cost for metering hot water up to 250°F. A special high temperature grease is employed for efficient lubrication. Venturi design and all other special features of this streamline propeller-type meter are retained. The Propeloflo is extremely useful where a simple totalizing meter is desired. Further information may be had by writing Builders-Providence, Inc., (Division of Builders Iron Foundry) Providence 1, R. I.

New Line of Hand Tools

Prepared for immediate reconversion, the Oscar W. Hedstrom Corp., 4836 West Division St., Chicago, Ill., will produce a new line of hand tools to supplement its manufacture of aluminum alloy products and complete line of drill jigs and fixtures.

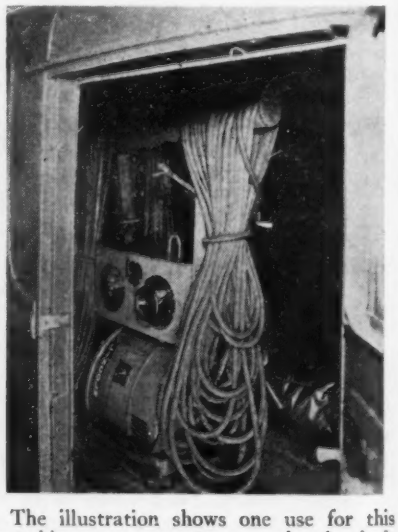
Developed by John V. Larson, the series of tools features the "Larc-o-matic," an automatic, adjustable, rachet-action wrench, and includes the "Speed-o-matic," a companion to the "Larc-o-matic"; the "Rocke-rench," a new improved pipe wrench; the "Fulc-o-matic," an automatic "plierench"; "Grip-o," a companion to the "Rocke-rench"; and "Over-Grip," an adjustable nut wrench.

The "Larc-o-matic" provides an instant thumb-trigger adjustment and an automatic "eye" adjustment control that keeps the jaws in constant grip on square, hexagonal, metric and odd sized nuts while the wrench handle is in manual operation. It automatically ratchets and secures a $1/4$, $1/6$, $1/8$, and $1/12$th turn grip for close quarter work. This positive grip prevents rounded nuts, reduces the danger of skinned knuckles, and eliminates frequent use of various sizes of end-wrenches.

In addition this slip-proof ratchet action wrench prevents marring of brass and nickel nuts and eliminates fumbling with thumb screws to adjust for size. Larc-o-matic wrenches will be produced in two styles. The first will utilize a V-groove in the jaws to grip corners and faces of nuts alternately for close quarter work, while the second type will have pipe wrench teeth for use on rounded nuts.

New Power Take-Off Has Wide Application

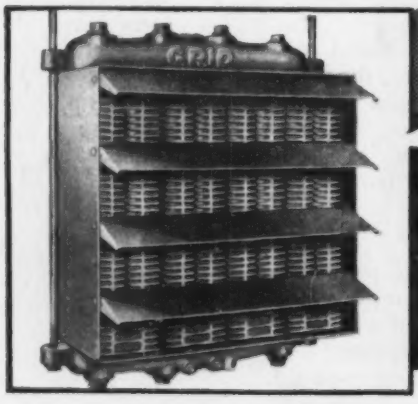
An idea in a power take-off direct-connected to a truck motor and eliminating the conventional V-belt drive, comprises one of the most compact set-ups of this kind and permits a more convenient and efficient means for making readily available various power applications wherever they are required.



The illustration shows one use for this portable power arrangement whereby it is used to drive the generator for an arc welding outfit supplied by The Lincoln Electric Co., Cleveland, Ohio.

The power take-off, designed and built by A. Tangen, 3269 Hogarth, Detroit, Mich., can quickly be installed in any Ford or Dodge truck as a permanent set-up, although it can easily be removed or reinstalled in a few minutes. Built as a unit, the driving mechanism fits directly over the standard transmission case of the truck and does not interfere in any way with the normal use of the truck.

This is said to be a very economical and convenient method for supplying generator power from the truck motor without the use of belts. Power is transmitted direct from the motor, thus the speed of the generator is the same as that of the motor. This has been found entirely satisfactory although



Install!
. . . HEATING EQUIPMENT THAT WILL LAST FOR YEARS.
GRID UNIT HEATERS

HIGH TEST CAST IRON UNIT
ONE PIECE CONSTRUCTION
NO SOLDERED, BRAZED WELDED OR EXPANDED CONNECTION
NOTHING TO BECOME LOOSE

• One piece construction heating sections (patented) of high test cast iron and will withstand steam pressures up to 250 lbs.
• No soldered, brazed, welded or expanded connections to become loose or develop leaks.
• No electrolysis to cause corrosion, break-downs, leaks or heating failures.
• It's the material that makes a difference in GRID Unit Heaters. That's why they are free from maintenance expense. Many units in operation 15 years without any maintenance. Capacity tables upon request.

SEND
New booklet "Corrosion in Unit Heaters" contains information you should know before you install unit heaters. It's free upon request. Send for it today.

D. J. MURRAY MANUFACTURING CO. WAUSAU WISCONSIN

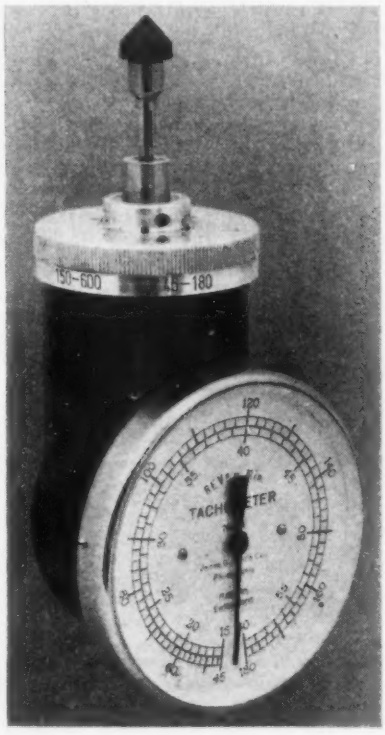
• Keep Informed

the speeds could be varied if necessary under special gear ratios. The governor, which can be cut in or out quickly, is connected with the power take-off.

In the installation illustrated the welder generator and supplemental equipment are compactly positioned in the truck immedimely behind the cab.

The outfit is available as a kit with complete instructions for mounting, or it can be installed in the truck by the manufacturers.

New 5-Range Precision Tachometer



James G. Biddle Co. announces a new precision direct-indicating hand Tachometer of type and quality similar to the fine instrument which they supplied before the War. This new instrument has two scales and five different ranges, viz.:

45 to	180 rpm
150 to	600 rpm
450 to	1800 rpm
1500 to	6000 rpm
4500 to	18000 rpm

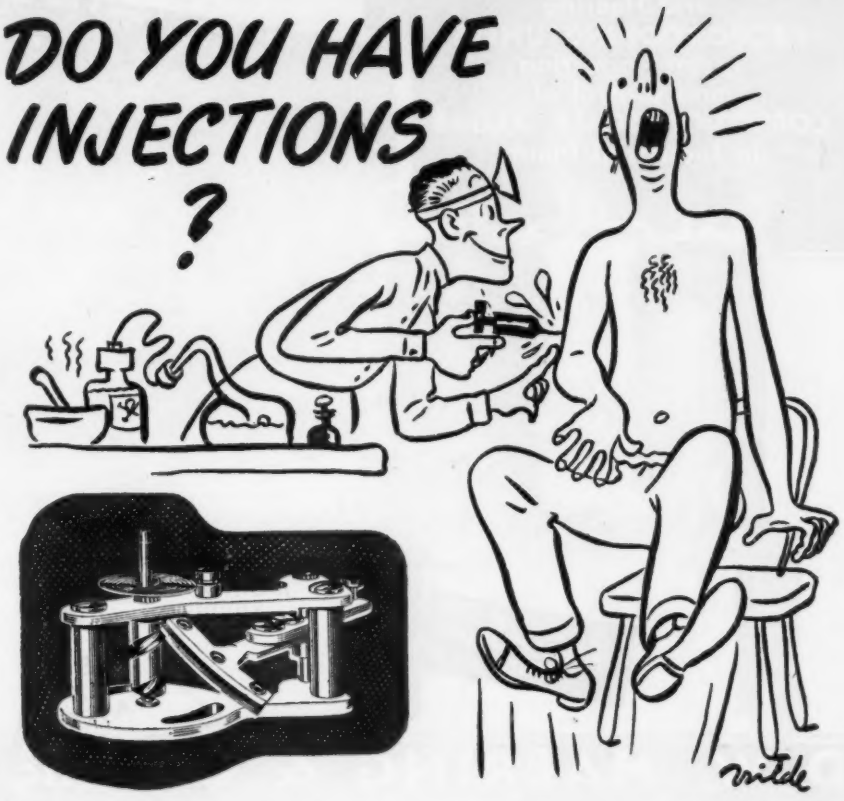
Change of range is by rotation of knurled barrel head. Instrument is supplied complete with carrying case and accessories, including a six-inch circumference wheel for measuring surface speeds. Bulletin in preparation. James G. Biddle Co., 1211 Arch Street, Philadelphia 7, Pa.

The F. & P. Rotasleeve for Large Flows

The new Fischer & Porter Rotasleeve effectively utilizes all the basic advantages of the area-type flow meter for the measurement of large flows of liquids and gases. A further development of the rotameter principle, this amazing new instrument gives you high accuracy, straight line calibration, wide flow range, low pressure loss and instantaneous response to flow changes. All this is available at a cost far below that expected for instruments handling such large capacities.

The Rotasleeve is a tapered metal sleeve which fits into standard pipe tees from sizes 3" and up. The flow enters the bottom of

Continued on Page 32



WE hope you never have injections like injection molding machines. They get injections so rapidly and under such high pressures that the shocks are terrific. These machines for molding plastics require pressure gauges. Ordinary gauges made with spur geared movements can't take this punishment — they are wrecked in no time at all by the sudden and violent pressure fluctuations. But Certified Gauges can take it. Only Certified Gauges with the Helicoid movement stand up under such severe service.

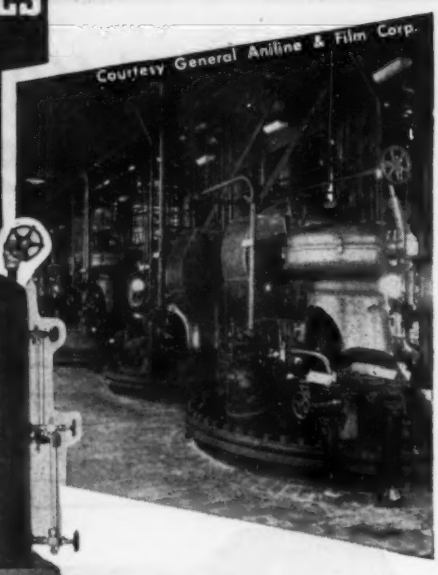
This is only one typical example of how Certified Gauges are cutting down maintenance expense in industry. Most every plant has pressure gauge trouble — brief service life, frequent repairs, inaccurate indications. The answer to such trouble has been found by all those companies now standardizing on Certified Gauges.

See your nearest Distributor.

Certified GAUGE
AND INSTRUMENT CORP.

HAERING GLUCOSATES

and Haering
PROPORTIONING UNITS
assure correction
and control of
CORROSION, SCALE, ALGAE
in Industrial Plants



WRITE FOR
"H-O-H WATER
STUDIES"

WE
READ
WATER

D. W. HAERING & CO., Inc.
GENERAL OFFICES:
205 West Wacker Drive, Chicago 6, Ill.

KNOW HOW *Expressed in Dependability Plus Top-Flight Performance*

Aurora Deep Well Turbines for all conditions—4" to 24"

You may place full confidence in "PUMPS by Aurora." They are products of experience and built by an organization exclusively engaged in the building of fine pumps.

We regard every pumping job as important—your assurance of full satisfaction as you entrust your exacting requirements to "Pumps by Aurora."

You are invited to acquaint yourself with Aurora Centrifugal and Apco Turbine-Type Pumps—a size and type for every need in industry.

NSA Aurora Centrifugal Sump Pump

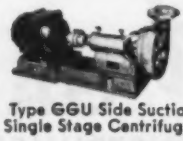
WRITE FOR CONDENSED CATALOG M

OR

Type OD Hor. Split-Case Double Suction Single Stage Centrifugal

Type AD Hor. Split Case, Two Stage Centrifugal

APCO Horizontal Condensation Return Unit



Type GGU Side Suction Single Stage Centrifugal

APCO Single Stage Turbine-Type

Type GMC Close-Coupled Centrifugal

DISTRIBUTORS IN PRINCIPAL CITIES

AURORA Always PUMPS

AURORA PUMP COMPANY

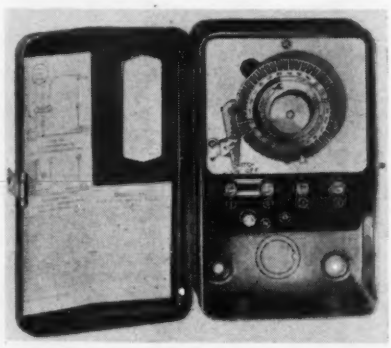
96 Loucks Street, AURORA, ILLINOIS

• Keep Informed

the Rotasleeve causing the flow indicating float to move upward and to assume a position in direct proportion to the actual rate of flow. Flows as large as 14,000 GPM of liquid and 16,000 CFM of gas can be handled. The Rotasleeve is made for direct reading and for remote reading in recording and recording-controlling types. Write for Bulletin 82-A which gives complete information. It will be sent to you gladly, without obligation, upon your request to Fischer & Porter Co., 9707P County Line Road, Hatboro, Pa.

Paragon 300 Series Time Switches Now Telechron Motored

Latest improvement in the Paragon 300 Series Time Switches is the Telechron Motor. An industrial type, self-starting synchronous motor which adds years to the life of the time switch. Operating advantages of this type motor are many . . . complete, self-oiling lubrication by patented capillary oiling system . . . practically instantaneous self-starting at full rated load . . . gear reduction fully sealed to exclude dust and dirt . . . low power consumption.



Constructed to give efficient performance, the 300 Series is light in weight, small and compact in design, has switch capacity of 3000 watts per pole with easily mounted-accessible terminals, skip-trip feature, knock-outs on both sides, back and bottom, and two bearing plate construction.

300 Series Time Switches are widely used for controlling signs, commercial lights, attic fans, stokers, oil burners, blowers, pumps, valves, motors, etc. These time switches may now be purchased without a priority rating.

Further information is available from Paragon Electric Co., 37 West Van Buren St., Chicago 5, Ill.

"Unit" Power Plants Designed for European Rehabilitation

Small, easily transportable power plants which can be erected in a few days to generate electric current sufficient for the needs of a city of 10,000, are being shipped to Europe to speed the return of bombed-out regions to normal industrial production, according to William E. Knox, Vice President of the Westinghouse Electric International Co.

Each "unitized" plant embraces the primary essentials of a modern power station, Mr. Knox explained. These include generator, steam turbine, boiler, switchgear, fuel burning equipment, piping and insulation, instruments and other parts.

More than 100,000 kilowatts of electrical energy—the power equivalent to 50 liberty ships or nearly 1400 automobiles—are represented in the unit plants now in actual operation or under construction, Mr. Knox said. The units are of two sizes, one with a capacity of 2,000 kilowatts, the other half as large.

LUBRIPLATE No. 130-A

LUBRICATION PLUS!

A SUPER LUBRICANT—A MARVELOUS ANTI-SEIZE COMPOUND—A REAL PROTECTION AGAINST RUST AND CORROSION. From the standpoints of general utility and wide diversity of important uses, we do not believe there has ever been a lubricant that compares with LUBRIPLATE No. 130-A. It has everything. The outstanding performance of this super-lubricant and its adoption by industry in general, and the Army and Navy are certainly adequate proof of its superiority. Write for copy of bulletin No. 6-41.

LUBRIPLATE
Lubricants definitely reduce friction and wear to a minimum. They lower power costs and prolong the life of equipment to an infinitely greater degree. LUBRIPLATE arrests progressive wear.

LUBRIPLATE
Lubricants protect machine parts against the destructive action of rust and corrosion. This feature alone puts LUBRIPLATE far out in front of conventional lubricants.

LUBRIPLATE
Lubricants are extremely economical for reason that they possess very long life and "stay-put" properties. A little LUBRIPLATE goes a long way.

Write for a booklet, "The LUBRIPLATE Film" written especially for your industry.

LUBRIPLATE
FISKE BROTHERS REFINING CO.
NEWARK 5, N. J.
TOLEDO 3, OHIO
OUR 75TH YEAR
1870 - 1945
DEALERS FROM COAST TO COAST

• Keep Informed

An instance was cited by Mr. Knox in which the unit plants already have played a vital role.

"When Allied troops occupied shell-blasted Salerno," he said, "they found the city's electric plant badly torn up by the retreating Nazis.

"While two British destroyers tied up at the docks to provide emergency power, engineers hastily unloaded and set up new power plants, which soon were generating the vitally needed current to restore the city's crippled utilities and ease the suffering of the inhabitants.

"Plants are now on their way to the Netherlands, where, with the aid of hastily imported electrical pumping equipment, they will be used to pump back into the sea waters let in when the Nazis destroyed the dikes," Mr. Knox said.

A result of five years of development, the plant designed for European use is the third model produced by Westinghouse technicians, Mr. Knox pointed out, and was specifically intended to serve as a provisional means of restoring ravaged sectors.

The idea of a compact power-producing unit first was conceived by Mr. Knox for use in China, following a trip to that country in 1939. The Chinese, in their fight against the Japs, needed a quick means of generating electrical power for war production facilities which had been forced back from the coast and deep into the interior by the advancing Nipponese troops.

Working in conjunction with a firm of New York engineering consultants, Westinghouse designers fulfilled the demand for equipment that would operate on locally abundant low-grade coal. Other models have been built to burn lignite, oil, wood and even peat.

"Delivery of these plants to China had only begun when Jap advances closed the Burma Road, shutting off China's overland communication with her Allies," Mr. Knox said. "But the European War created another need, and also entailed a modification of design.

"While the first plants were intended for what the engineers call 'dis-assembled shipment' for permanent erection at the ultimate site, the rapid pace of the mechanized conflict upset the engineers' timetable and called for a machine that could be put together in a minimum of time."

The result of this need, he said, was a "semi-portable design" which fulfilled the purpose, and, in addition, could be set up right on the field.

But, he added, as one Allied invasion after another hit the continent and peace neared, the emergency requirements of the approaching rehabilitation period presented new problems for the engineers.

"To meet this situation, an 'austerity model,' which simplified the arrangement of the major components and eliminated all dispensable refinements, was designed," said Mr. Knox.

Westinghouse unit steam power plants of various types have been purchased for use in Russia, Italy, the Netherlands, China, French North Africa and South America, Mr. Knox said.

Despite the diverse climates in which these plants will be used, ranging from bitter tundras to steaming jungles, engineers had to allow for only two variables in the design: type and grade of fuels available; and what engineers call "ambient temperature"—the air temperature at the site where the plant is set up.

Temperature is an important factor, Mr. Knox explained, because "used" steam must

Continued on Page 35

LUBRIPLATE No. 70

LUBRICATION FOR WHERE IT'S HOT AND WET!

LUBRIPLATE No. 70 is a medium density, grease type lubricant ideal for applications exposed to heat, steam and moisture. It does a wonderful lubrication job under all conditions. In processing and food plants where moisture, steam, heat and fumes are prevalent, it has no substitute. Machines lubricated with LUBRIPLATE No. 70 can be washed down with hot water without harming the lubricant in the bearings. LUBRIPLATE No. 70 prevents rust and corrosion.

℞ FOR YOUR MACHINERY

No. 3—Ideal for general oil type lubrication. Ring oiled bearings, wick feeds, sight feeds and bottle oilers.

No. 8—Because of its high film strength and long life reflects outstanding performance in most types of enclosed gears (speed reducers)

No. 107—One of the most popular grease type products for general application by pressure gun or cups.

No. 70—For a wide range of grease applications, especially at temperatures above 200 degrees F.

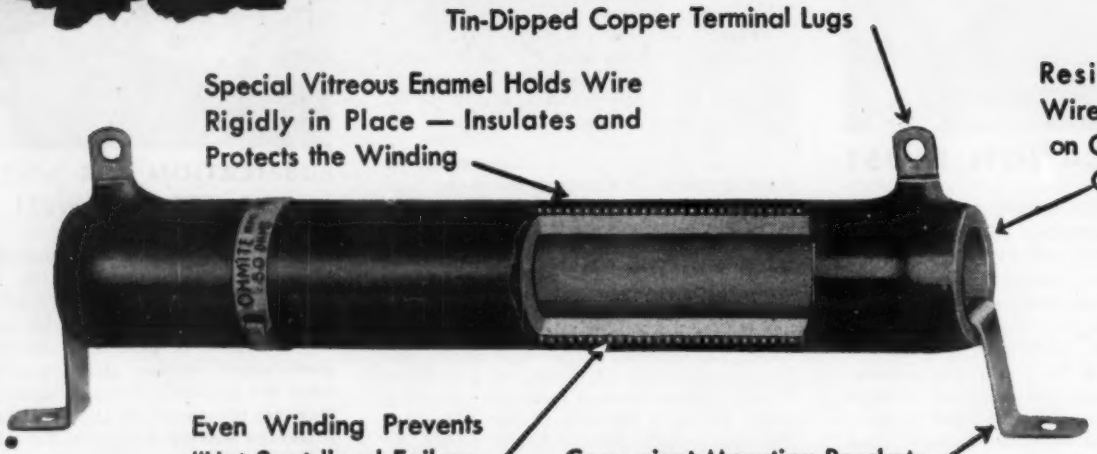
No. 130-AA—Known nationwide as the superior lubricant for open gears, heavy duty bearings, wire rope, etc.

BALL BEARING—This is the LUBRIPLATE lubricant that has achieved wide acclaim for use in the general run of ball and roller bearings operating at speeds to 5000 RPM and temperatures up to 300 degrees F.

Write for a booklet, "The LUBRIPLATE Film" written especially for your industry.

LUBRIPLATE
FISKE BROTHERS REFINING CO.
NEWARK 5, N. J.
TOLEDO 3, OHIO
OUR 75TH YEAR
1870 - 1945
DEALERS FROM COAST TO COAST

Why OHMITE Resistors PERFORM SO DEPENDABLY


Tin-Dipped Copper Terminal Lugs
Special Vitreous Enamel Holds Wire Rigidly in Place — Insulates and Protects the Winding
Resistance Wire Wound on Ceramic Core
Even Winding Prevents "Hot Spots" and Failures
Convenient Mounting Brackets

Here you see a few of the important features that insure long life and trouble-free service in every Ohmite Resistor. In the lug type illustrated above, the resistance wire is both mechanically locked and brazed to copper terminal lugs to assure perfect electrical connection. Time-proved Ohmite vitreous enamel construction dissipates heat rapidly . . . withstands humidity. Today, Ohmite Resistors are extensively used in the Armed Forces, Industry, Communications, Research. *Made in a wide range of types and sizes* in stock and special units for every need. Consult Ohmite engineers on your resistor problem.

OHMITE MANUFACTURING COMPANY
4809 FLOURNOY ST., CHICAGO 44, U. S. A.

Write on company letterhead for Industrial Catalog and Engineering Manual No. 40. Gives helpful information on resistors, rheostats, chokes, tap switches.

Be Right with OHMITE
RHEOSTATS • RESISTORS • TAP SWITCHES

• Keep Informed

be converted back into water by condensation for re-use and air temperature greatly affects the ease with which this condensation takes place. Therefore, different design characteristics for the condensers have to be provided for different climates.

The original intent of Westinghouse engineers in the preparation of the "unit" designs was to relieve purchasers of the complex task of technical design and equipment selection and to enable them to buy from a single source all the necessary apparatus properly co-ordinated.

About 40 per cent of the apparatus for the completed units is manufactured by Westinghouse, the remainder by 20 sub-contractors, it was pointed out.

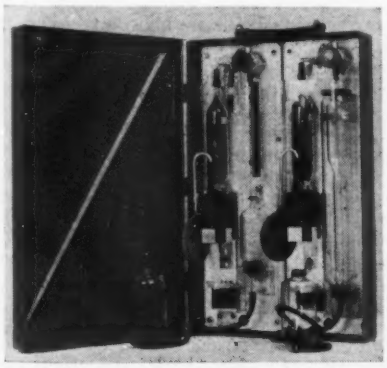
Industrial Control Assemblies to Add Portability Feature

Increased user convenience through improved portability of industrial instruments has been made possible by Brown Instrument Co., Wayne and Roberts Avenues, Philadelphia. The improvements consist of assemblies, comprising handles and parts, furnished unmounted so purchasers can attach them according to individual requirements.

Two assemblies will be available, it was made known by the Philadelphia industrial division of Minneapolis-Honeywell Regulator Company. These will consist of: 1. A cast carrying handle, plus parts, for smaller instruments such as meters and gauges. 2. Two locker type carrying handles, with feet and necessary assembly parts for heavier potentiometer types, including electronic.

War Needs Result in Development of New Type of Gas Analyzer

The Hays Corp., Michigan City, Ind., pioneer manufacturer of gas analyzing equipment, announces the development of a special analyzer for testing the high purity of oxygen, carbon dioxide, and nitrogen in the range from 90% to 100%.



It is of particular interest to the manufacturers of commercial oxygen and carbon dioxide but has many practical uses also in industrial processes. The new analyzer known as the Hays Series "E" came into being as the result of the demand for testing the high purity of oxygen for use in flying, etc. It is quite similar to the standard orsat but its technique in operation differs somewhat.

It is offered in two styles—a wall mounted model for permanent installation and a portable model supplied in a neat metal case with leather carrying handle. It may be had with a single unit or with two units. A junior model (Series EJ) is also obtainable with a burette capacity of 30 cc. The smaller model measures $6\frac{1}{4}$" × $9\frac{5}{8}$" × $3\frac{3}{4}$" and weighs, fully charged, less than six pounds.

Continued on Page 36

Now! an IMPROVED

KENNAMETAL LATHE FILE

- CUTS STEEL NO ORDINARY FILE CAN TOUCH
- PERMITS FILING SPEEDS 3 TO 10 TIMES THOSE POSSIBLE WITH STEEL FILES!
- OUTLASTS MILL CUT FILES 50 TO 200 TIMES

This new Kennametal Lathe File retains all the time-and cost-saving characteristics of previous designs—*cuts steel up to 62 Rockwell C hardness; does outstanding job on cast iron and non-ferrous materials; permits filing operations at carbide tool turning speeds; produces superior finish.*

And now, in addition, it provides these new features—*longer filing surface; quick, easy blade replacement; greater handling convenience.*

The filing surface comprises two 4" long Kennametal blanks which have cylindrical nuts brazed to them, and are attached to the aluminum alloy handle by screws. After long service (up to 200 times that obtained from steel files) the blanks can be readily replaced.

The handle grip has a thumb rest and knuckle guard. An extension of the handle beyond the filing surface provides a secure finger hold. A hole in this extension permits the file to be hung up.

On the first production run, a Kennametal Lathe File usually saves its cost many times over. Order one—let it demonstrate to you an astonishingly low filing cost-per-piece.

Features

REPLACEABLE BLANKS

Kennametal blanks are attached by Phillips head screws. Two types are available: fine (30 teeth per inch); and coarse (20 teeth per inch).

LIGHT WEIGHT

Weighs less than one pound. Can be handled with ease, and used for long periods of time with minimum expenditure of energy.

HAND-FITTING GRIP

Handle is comfortable—it fits the hand; provides secure grip. Opposite end of file provides convenient finger hold.

KENNAMETAL

SUPERIOR CEMENTED CARBIDES

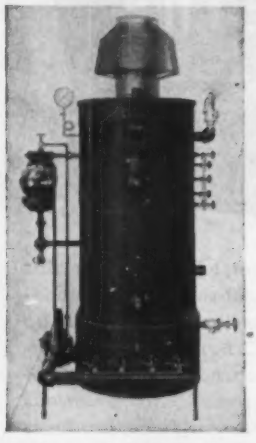
KENNAMETAL Inc., LATROBE, PA.

SPECIFICATIONS AND PRICES

COMPLETE FILE		FILE BLANK—2 REQUIRED		
CAT. No.	PRICE EACH	CAT. No.	TEETH/ INCH	PRICE EACH
F-45*	$18.50	F-453	30	$7.50
		F-452	20	7.50

* Furnished with blanks having 30 teeth/inch unless otherwise specified.

New Equipment ...for Post War



Specifications are being written today for the products of tomorrow. Engineers are specifying the scientifically designed KANE to give trouble-free operation, wherever an automatic gas-fired steam boiler in sizes up to 30 H.P. is needed.

Built to A.S.M.E. Code, taking up only minimum floor space, the up-to-date KANE can generally be placed right next to the equipment it serves.

For replacements or new installations, specify the KANE for post war jobs.

MEARS-KANE-O'NEILL INC.
Manufacturers of Automatic Steam Boilers for over a third of a century.
1903-1915 EAST HAGERT STREET, PHILADELPHIA 25, PA.

• Keep Informed . . .

All models feature a new four-way valve designed by Hays engineers to conserve space and facilitate operation. An explanatory bulletin (Pub. 45-743) will be sent to those interested. Write the Hays Corp., Michigan City, Indiana.

SR4 Strain Gage

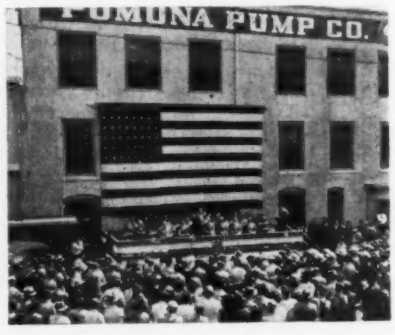
New uses for a testing gage the size of a postage stamp which is solving engineering problems heretofore considered impossible will be the basis for a conference of research engineers at the Waldorf-Astoria Hotel in New York City on Sept. 27 and 28. The Baldwin Locomotive Works' Southwark Division, manufacturers of the gage known as the SR4 strain gage, will sponsor the conference.

Since its introduction about four years ago the gage has been used for determining stresses and strains in hundreds of different applications and it is to determine further uses as well as to demonstrate its present applications, that the conference has been called. Other testing equipment in Baldwin's Southwark line also will be on display and will be described and demonstrated by the company's representatives.

Safety in Industrial Plants Is Important

Because of the accident rate in industrial plants, a little more than three years ago the President of the United States called upon the National Safety Council to mobilize the safety forces of the country to make a concerted attack upon the factors that were causing the loss of lives and time so vitally important to the war effort.

The activity of the Council has become the most significant development in the history of the safety movement. As a part of their nation-wide campaign to save man power for war power the Distinguished Service to Safety Award was instituted by the National Safety Council in October of 1942. The intent of the Award is two-fold—to call attention to outstanding accident prevention performances of American war plants under war time pressure, and to publicize the safety movement not only to industrialists but to the general public. It is important for both fully to realize that safety is a powerful factor in the conservation of national energy for the war effort.



Among the first recipients of this award in the eleven western states was the Pomona Pump Works of Fairbanks, Morse & Co. The presentation to the Pomona Plant was made on June 15, 1945, the program of which was broadcast over Radio Station KFI of Los Angeles.

Other prominent recipients of the award in the western states are the California Shipbuilding Corporation, the Union Pacific Railroad, the Bethlehem Steel Company at San Pedro, the Standard Oil of California, and the Bethlehem Alameda Ship Yard.

The story of how this award was won by the Pomona Plant of Fairbanks-Morse is interesting not only in itself, but because it can be helpful to many industries which have an accident prevention problem. Factors contributing to the success of the Safety Program at Fairbanks-Morse are the cooperation of all executives, superintendents, foremen, and all of the employees. More directly, the success of accident prevention can be traced to the Safety Committee who meet each month to discuss and iron out problems connected with the Safety Program. This committee is made up of workmen chosen from various departments of the plant. These men began their work with a fifteen week Safety Engineering class conducted at the plant, under the auspices of the University of California, by Mr. J. P. Anderson and Thomas Halpin, the instructors.

The dissemination of safety knowledge throughout the plant by the Committee helped immeasurably to create an active interest by everyone. It eliminated particularly the tendency to depend upon chance for the prevention of accidents. Chance, of course, has no part in safety work. It is a scientifically, well thought-out plan that does the job.

During the year 1943 there occurred in the Pomona Plant 107 time-lost accidents. These accidents totaled 7434 man days of production that could not be regained. The more serious side of the picture included one fatality and four permanent disabilities. The year 1944, however, when the Safety Program, as now constituted, was put into effect, showed a reduction of time-lost accidents to 28 and man days lost to 223. There were no

TWO IMPORTANT NEW BOOKS

NETWORK ANALYSIS and FEEDBACK AMPLIFIER DESIGN by Hendrik W. Bode, Ph. D.

Member technical staff, Bell Laboratories
568 Pages. 6¼" x 9¼". Cloth. Illustrated. $7.50

This book meets the need for a more fundamental approach to network theory in order to solve the problems raised by the important new circuits and equipment of today.

As in Dr. MacColl's book, the treatment is consistently practical. The great advances of recent years have shifted the engineering emphasis from narrow-band problems to broad-band problems, and from passive networks to networks including or intimately associated with vacuum tubes. In this new book the theory is extended to cover these needs.

To the student of television and frequency-modulation systems, which will be so important in the days ahead, Dr. Bode's work should be extremely helpful. And to everyone engaged in this field, the contribution made by this book to the solution of present-day problems in network analysis is such that acquaintance with it is a "must."

FUNDAMENTAL THEORY OF SERVOMECHANISMS by Leroy A. MacColl, Ph.D.

Member technical staff, Bell Laboratories
133 Pages. 6" x 9". Cloth. Illustrated. $2.25

This book furnishes the links in mathematical reasoning necessary to use the available feedback amplifier theory and mathematical methods in solving problems in servomechanisms.

It is therefore a direct aid to the man who must make practical applications of servomechanisms. In addition to the basic mathematical theory, it includes a study of a simple, yet frequently used servomechanism.

A few of the chapter headings indicate the scope of the book: Provisional definition; Description and rudimentary theory; Auxiliary formulae; Stability; Performances. Also included is much hitherto unpublished information—on oscillating control and sampling.

Emphasis is placed upon the essential identity of servomechanism theory with the highly developed theory of feedback amplifiers. This volume, therefore, may well be used in conjunction with "Network Analysis" by Dr. Bode, described here.

ORDER TODAY

Use this convenient coupon to obtain either one or both of these important new books.

D. VAN NOSTRAND COMPANY, INC.
250 Fourth Ave., New York 3, N. Y. Mech. Eng. 9-45

Please send me ... copies of FUNDAMENTAL THEORY OF SERVOMECHANISMS @ $2.25.

Please send me ... copies of NETWORK ANALYSIS & FEEDBACK AMPLIFIER DESIGN @ $7.50.

I enclose check ... Money order .... Send C.O.D. ...
(Please indicate which)

SIGNED.....

ADDRESS.....

CITY..... STATE.....

• Keep Informed

fatalities and no permanent disabilities. While this is a good record, the year 1945 is shaping up even better. This year to date the accidents at the Pomona Works have been negligible.

So it is that education and dissemination of safety information, and a willingness to cooperate, have added up to this splendid achievement, which is culminated in the presentation by the National Safety Council of their Distinguished Service to Safety Award.

The theme of the presentation ceremony was stated in the opening sentence of the radio broadcast. It was "This is the story of America's most powerful weapon." Bob Purcell of Radio Station KFI summed up America's most powerful weapon in these words, "Americans . . . we have 130 million like them all over this nation and these are typical of all the others like them . . . this group we have here today are in Pomona . . . yes, the same Pomona that Bob Hope kids about . . . that's another thing that confuses the enemy—how can we make jokes about our most sacred institutions . . . we can, but don't anybody else try."

The award was presented by Mr. J. C. Stennett, of the National Safety Council, to Mr. R. H. Morse, Jr., vice-president of Fairbanks, Morse & Co., who turned it over to the employees at the plant. In his presentation talk, Mr. Stennett said, "Such a record is something for you to be proud of. It is in the highest sense an inspiration. It is an inspiration to the workers, who cannot help but appreciate your interest in safeguarding their lives and limbs—it is an inspiration to other firms, both large and small, which will say, 'If Pomona can do, so can we.' Finally, it is an inspiration to the National Safety Council and to each safety organization in the country."

Mr. Stennett further remarked, "So, I would like to offer the congratulations of the National Safety Council to all of the officials and all of the employees of the Pomona Pump Works. If I may, however, I would like to single out one person for individual commendation—that person is T. F. Halpin, your very fine safety engineer. But I'm sure that Mr. Halpin will agree with me that everyone in the plant deserves credit."

In accepting the honor, Mr. Morse addressed himself to the plant employees, saying, "Now then you fellows and girls, I am not going to make a formal speech about the swell job you have done . . . I just want you to know that your making this occasion possible means very much to me . . . for that—my sincerest thanks . . . What this safety award means to us, the company, I think you all know . . . we're proud of you. I wonder, however, if you wouldn't give me the privilege of speaking as one of you to tell you what I think it means to us, the working men. After all, Colonel Morse, who unfortunately couldn't be here today, saw to it that I found out the difference between a Diesel and a Pump before I was very old. I have worked in the shop and I know that I used to cuss safety guards and devices for slowing me up; still and all, if it weren't for those guards I might not have a full complement of ten fingers to grab on to this penant today. As far as slowing up production . . . take a look at the production figures . . . all those pumps and a safety award too. The point I want to make is, it's a nice feeling as a worker to know that everything is being done to protect us from accidents, and that the greatest protection was brought about by our own good judgment and common sense . . . anyway . . . as a working man or as an executive . . . again thanks."

Continued on Page 38

Interchangeable Parts

MEAN EASIER, LOWER COST VALVE MAINTENANCE

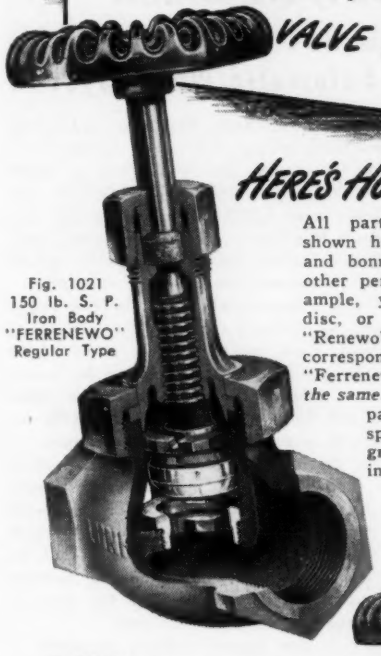


Fig. 1021
150 lb. S. P.
Iron Body
"FERRENEWO"
Regular Type

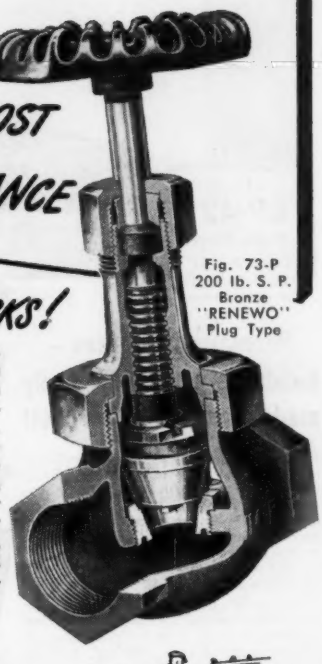
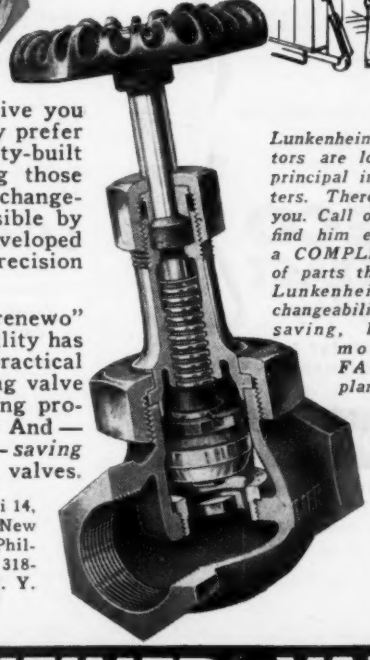


Fig. 73-P
200 lb. S. P.
Bronze
"RENEWO"
Plug Type

HERE'S HOW IT WORKS!

All parts of the valves shown here (except bodies and bonnet rings) fit each other perfectly. If, for example, you need a stem, disc, or seat ring for the "Renewo", you can use the corresponding part of the "Ferrenewo"—*it is exactly the same.* This means fewer parts to be carried, speedier repairs, and greater ease in making them.



● Maintenance men can give you a flock of reasons why they prefer LUNKENHEIMER quality-built Valves. Prominent among those reasons is the *wide* interchangeability of parts made possible by Lunkenheimer's highly developed simplicity of design and precision workmanship.

In the "Renewo" and "Ferrenewo" Valves, this interchangeability has long been of highest practical value to industry, in making valve maintenance easier, speeding production, lowering costs. And—vitally important today—*saving fuel* that comes from tight valves.

Lunkenheimer Distributors are located in the principal industrial centers. There is one near you. Call on him—you'll find him equipped with a COMPLETE STOCK of parts that will make Lunkenheimer "interchangeability" a time-saving, labor-saving, money-saving FACT in your plant!

The Lunkenheimer Co., Cincinnati 14, Ohio, U. S. A. Branch Offices: New York 13, Chicago 6, Boston 10, Philadelphia 7. Export Department: 318-322 Hudson St., New York 13, N. Y.

Fig. 73
200 lb. S. P.
Bronze
"RENEWO"
Regular Type

LUNKENHEIMER VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S. P.; BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS

NOW! A CONTINUOUS APĒCO PHOTO-COPYER

that gives you prints up to 42 inches wide —any length!

APĒCO **CP-421** Photo-Copyer Copies up to 42" wide, any length

Also smaller models down to 18" x 22"

BLUE PRINTS

PENCIL SKETCHES

LETTERS

SPECIFICATIONS

TRACINGS

DRAWINGS

GRAPHS

CHARTS

OVER 100 OTHERS

Permanent copies—hundreds per hour—easily made at amazingly low cost!

Here's today's best investment in large photocopy equipment! This new APĒCO machine turns out photocopies, *large or small*, at production-line speed! Makes permanent, error-proof copies of anything written, typed, printed, drawn or photographed—even if on both sides. Ideal for making photographic tracings.

As fast as one or more operators can place copy on the continuous belt, *this machine can take it*, delivering exposed prints ready for processing. It's as simple as that . . . no darkroom or technical knowledge is needed—any boy or girl can operate it. Get sharp, clean prints—save time, money and labor. For full details on CP-421 and APĒCO accessories—automatic driers up to 60" wide, trays up to 40" x 50"—mail coupon today.

AMERICAN PHOTOCOPY EQUIPMENT CO.
2849 N. Clark St., Dept. JP95,
Chicago 14, Ill. (Representatives in principal cities and Canada)

The **APĒCO PHOTOEXACT**
"Copies Anything!"

AMERICA'S MOST WIDELY USED PHOTOCOPY EQUIPMENT

MAIL COUPON NOW!

AMERICAN PHOTOCOPY EQUIPMENT COMPANY
2849 N. Clark St., Dept. JP95, Chicago 14, Ill.

Send me your illustrated circular with complete information on APĒCO CP-421 and accessories.

NAME.....

TITLE.....

COMPANY.....

ADDRESS.....

CITY.....STATE.....

TROY, ALABAMA

Now Has a Layne Automatic Water System

City Officials of Troy, Alabama are in high spirits these days. Where all others have failed, Layne has just completed a water system WITHIN THE CITY LIMITS that produces over 1,000,000 gallons daily. Furthermore this new system is equipped with the latest automatic control device which eliminates manual starting and stopping.

Prior to the completion of this New Layne System, all water for the city of Troy was obtained from wells located some three miles away. The success achieved by Layne will now enable the city to install other wells and thus abandon the distantly located and expensive to operate system.

Here again is proof that Layne's experience, knowledge and specialization always pays handsome dividends. Building this well was no easy task. It was drilled through rock strata from one to sixteen feet in thickness. Some five-hundred bags of cement were used to seal off all but the desired water bearing sand formations.

Layne is now almost entirely engaged in civilian Well Water System building—and is ready to serve you. Write, wire or phone for further facts, catalogs, bulletins etc., LAYNE & BOWLER, INC., General Offices, Memphis 8, Tenn.

LAYNE PUMPS *—fulfill every need for producing large quantities of water at low cost from wells, streams, mines or reservoirs. Send for literature.*

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Texas Co., Houston, Texas ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Western Co. of Minnesota, Minneapolis, Minn. ★ International Water Supply Ltd., London, Ontario, Canada ★ Layne-Hispano Americana, S. A., Mexico, D. F.

LAYNE

WELL WATER SYSTEMS
VERTICAL TURBINE PUMPS

• Keep Informed

Tank Repair Device Wins "E" Award

Templeton, Kenly & Co., prominent in the manufacture of industrial jacks since 1899, was granted the Army Navy Production Award by Robert P. Patterson, Undersecretary of War, recently.

The company's most prominent contribution to the war effort has been a special track connector for the speedy mounting, demounting and repair of tank crawler treads. This unit has seen service wherever American-built tanks have gone, and has proved of especial value where the going was tough and repairs frequent. Large numbers of conventional Simplex hydraulic, screw and lever jacks have been used in shipbuilding, construction, railroading and many other phases of the war effort.

The "E" burgee was raised and ceremonies were held at the company's plant, 1020 South Central Avenue, Chicago.

Fifth "E" Star Awarded to De Laval

In recognition of the continuation of its excellent production record, the U. S. Navy has awarded the De Laval Steam Turbine Co. a Fifth Star for the Navy "E" Flag which has been held by that company without lapse since the awarding of the first Navy "E" to De Laval in May, 1942.

The products furnished by the De Laval Steam Turbine Co. to the Navy include: steam turbines, reduction gears, worm gear speed reducers, centrifugal pumps, IMO oil pumps, centrifugal compressors and blowers.

Flexitallic Gasket Co. Awarded Army-Navy "E"

A July 14th announcement from the Navy Department brings word of the awarding of the Army-Navy "E" to the Flexitallic Gasket Co., 8th & Bailey Streets, Camden, N. J. for outstanding achievement in the production of war materials. Ceremonies attendant to conferring the award will be held in the company's plant in the near future.

Largely engaged in meeting essential Navy requirements even before Pearl Harbor, the Flexitallic Gasket Co. has since devoted 100% of its efforts to war needs. Production has been increased many times over, and a complete new factory adjacent to the old one has recently been put into operation. As a result of these efforts, a large percentage of both combat and merchant craft are Flexitallic equipped and the gaskets are being used regularly in maintenance and in the repair of battle damage.

Flexitallic is the originator of spiral-wound construction whereby gaskets are made up of alternate spirally-wound layers of asbestos and interlocked strips of various metal alloys. This construction automatically compensates for pressure surges, vibration, expansion and contraction. Extremely heavy pressures and high temperatures can be handled safely, even under the rigors of the most severe combat conditions.

When the S. S. E. H. Blum of the Atlantic Refining Co. tanker fleet was raised after 4 months at the bottom in a spectacular salvage operation, she was reconditioned and sent back to sea with many of her original Flexitallic Gaskets still in service.

Almost equally important in speeding up the war effort is the ease with which Flexitallic Gaskets can be installed. When used recently on a large scale piping schedule in ship production, they resulted in a reduction of 5200 man hours per ship—exclusive of shop and laboratory time saved in testing and preparing valves and fittings for conventional gasket types.

• Keep Informed

• BUSINESS CHANGES

Export Corporation Formed

Colonel W. F. Rockwell, President of Pittsburgh Equitable Meter Company, Pittsburgh, Pa., has announced the formation of the Pittsburgh International Corp., with offices at 7701 Empire State Building, New York, N. Y. This firm will handle the export sale and distribution of products manufactured by Pittsburgh Equitable Meter Co., Merco Nordstrom Valve Co., and subsidiaries.

The Pittsburgh International Corp. will be under the direction of A. L. DiGiulian, Vice-President. Mr. DiGiulian has had extensive experience in foreign markets. He was educated in Europe, completing studies in Italy, Spain and Portugual. He was graduated from Georgetown University, School of Foreign Service, in 1927, and has since been honored by the University with a special certificate for his accomplishments in foreign service and with the Coutinho medal for his work in the Portuguese language. Mr. DiGiulian, who is an accomplished linguist, has spent many years in U. S. Government service. His immediate connection prior to accepting his new post was Chief, Foreign Communications Section, Office of Exports, Foreign Economic Administration, Washington, D. C

Mr. DiGiulian will be assisted in the operation of the export firm by George E. Doty. Mr. Doty, after attending Carnegie Institute of Technology, joined the Pittsburgh Equitable Meter Co. in 1926. His experience embraces all phases of manufacture and sale of the company's products. Prior to war he served as Export Manager. More recently Mr. Doty was assigned to the Merco Nordstrom Valve Division at the Oakland, California plant, as assistant to the General Manager.

The New York offices of the Pittsburgh International Corp. will be opened September 1, 1945.

Chiksan Forms Own Export Company

Increased activity in export markets is anticipated by the Chiksan Co., Brea, Calif., with the announcement of the establishment of an affiliate company to handle export sales. The new company, Chiksan Export Co., will headquarter in Brea, with branch offices in New York and Houston. The cable address is "Chiksan."

W. Edgar Spear, president of the Chiksan Co., heads the new export company in the same position, with Lee J. Laird, Chiksan vice president and sales manager, also in charge of export sales. The New York office at 50 Church St., will be managed by H. A. Maland and the Houston office, now in process of organization, with temporary mailing address P. O. Box 276, Houston 1, Texas, will be under the management of G. R. Winder who transfers to Houston from the Chiksan home office in Brea, Calif.

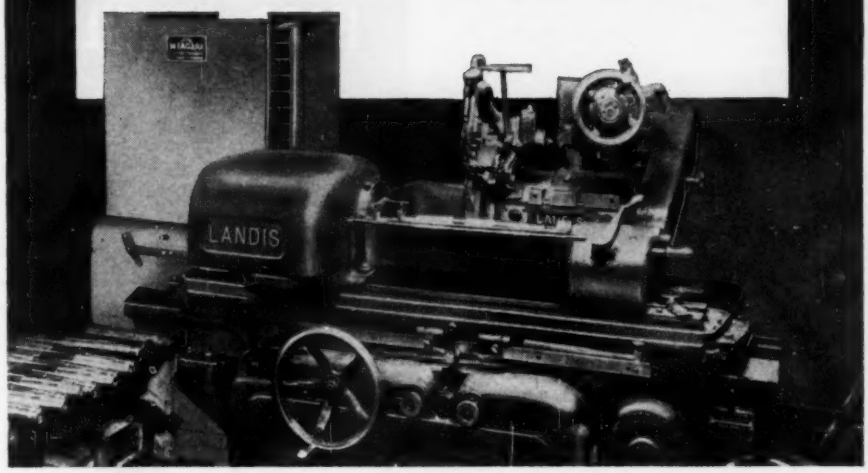
Mercury Clutch Moves to New Canton Plant

Mercury Clutch Corp. has moved into its new plant at 1520—12th Street, S. W., Canton, Ohio, according to an announcement recently received from A. M. Wickwire, president of the company. In its new quarters the company plans an increased production of its line of mercury-controlled clutches designed to facilitate the starting and acceleration of electric motors and internal combustion engines.

Continued on Page 40

WOULD MORE PRECISE TEMPERATURE CONTROL OF LIQUIDS OR GASES

IMPROVE YOUR PROCESS OR INCREASE YOUR PRODUCTION?



The NIAGARA AERO HEAT EXCHANGER holds the temperature of a liquid or gas within close limits. Many units have been installed because they provide a less expensive and less troublesome way of cooling fluids in an industrial process. But, after installation, users have discovered additional benefits of extra plant capacity, increased production and better quality production because the NIAGARA AERO HEAT EXCHANGER provided accuracy of temperature control.

Cooling of cutting oils, lubricants, quenching baths, engine jacket water; chemicals and intermediates; electronic sets; condensing gases, steam and refrigerants; controlled atmosphere processes; compressed air after-cooling—are processes in which these *extra* benefits are obtained.

For further information, write for Niagara Bulletins 90, 94 and 96, or ask about experience in your own field.

NIAGARA BLOWER COMPANY

Over 30 Years of Service in Industrial Air Engineering

DEPT. ME-95, 6 E. 45th St. NEW YORK 17, N. Y.

Field Engineering Offices in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING

NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

A.S.M.E.
POWER TEST CODES

Auxiliary Sections

Recently Completed and Published

CODE ON DEFINITIONS AND VALUES

If you use the A.S.M.E. Power Test Codes, it is important that you know the precise definitions of terms and the exact values of the constants employed in them. Your reliable source for this information is the new Code on Definitions and Values. Here are enumerated the units to be employed in reporting the results of tests made in accordance with various Power Test Codes, explanatory notes on data and computations of test codes, and the letter symbols and subscripts for heat and thermodynamics.

Published 1945 **Price 80¢**

CODE ON GENERAL INSTRUCTIONS

Before conducting tests it is advisable to have a knowledge of the general principles underlying the routine, commercial and acceptance tests of power machinery. The new 1945 Code on General Instructions provides the following information:

Part I—Object and Organization of Power Test Codes.

Part II—Standard Form of Individual Test Codes (Mandatory upon Committees writing or revising Codes).
Sections: 1, Object and Scope; 2, Definitions and Descriptions of Terms; 3, Guiding Principles; 4, Instruments and Methods of Measurement; 5, Computation of Results; 6, Report of Results.

Part III—Information for Code Users (Recommended for insertion in individual codes).
Sections: A, Object of Test; B, Preparation for Test; C, Instruments; D, Starting and Stopping; E, Operating Conditions; F, Records; G, Testing Technique; H, Sources of Error; I, Computation of Results; J, Averaging of Readings and Results; K, Test Report.

Part IV—Respective Responsibilities for Conduct of Acceptance Tests. Relation of Tests to Purchase Contracts. Adjustment of Controversies and Arbitration.
Sections: L, Cost of Acceptance Tests; M, Preliminary Tests and Adjustments to Equipment; N, Time Limits; O, Test Procedures, Apparatus, Corrections; P, Inconsistencies in Test Results; Q, Arbitration Procedure; R, Suggested Clause for Incorporation of A.S.M.E. Power Test Codes in Equipment Purchase Contracts.

Published 1945 **Price 45¢**

CODE ON INSTRUMENTS AND APPARATUS

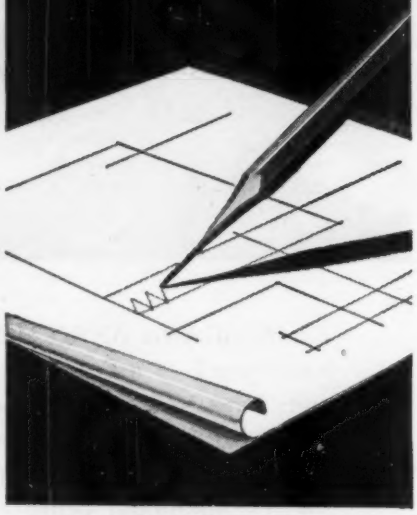
The following supplementary sections give descriptions of, and standard directions for, the use and calibration of measuring devices likely to be required for testing any power equipment.

Part2—Pressure Measurement
Chapters 1 and 6, Barometers, Tables, Multipliers and Standards Pub. 1941. 60¢
Chapter 4 (Bourdon, Bellows Diaphragm, and Deadweight Gages) Pub. 1938. 65¢
Chapter 5, Liquid Column Gages Pub. 1942. 75¢
Part 3—Temperature Measurement
Chapters 1, 5, 6 and 7 (Pyrometric Cones, Liquid-in-Glass Thermometers and Bourdon Tube Thermometers) Pub. 1931. 75¢
Chapter 2 (Radiation Pyrometers) Pub. 1936. 55¢
Chapter 3 (Thermocouple Thermometers) Pub. 1940. 65¢
Chapter 4 (Resistance Thermometers) Pub. 1945. 80¢
Chapter 8 (Optical Pyrometers) Pub. 1940. 35¢
Part 4—Head Measuring Apparatus Pub. 1933. 35¢
Part 5—Flow Measurement by Means of Standardized Nozzles and Orifice Plates
Chapter 4 Pub. 1940. $2.75
Part 6—Electrical Measurements Pub. 1934. $1.25
Part 8—Measurement of Indicated Horsepower Pub. 1941. 75¢
Part 9—Heat of Combustion Pub. 1943. 40¢
Part 11—Determination of Quality of Steam Pub. 1940. 45¢
Part 12—Measurement of Time Pub. 1942. 40¢
Part 13—Speed Measurements Pub. 1939. 45¢
Part 14—Linear Measurements Pub. 1936. 55¢
Part 15—Measurement of Surface Areas Pub. 1937. 75¢
Part 16—Density Determinations Pub. 1931. 30¢
Part 17—Determination of the Viscosity of Liquids Pub. 1931. 45¢
Part 18—Humidity Determinations Pub. 1932. 50¢
Part 20—Smoke Density Determinations Pub. 1936. 65¢
Part 21—Leakage Measurement
Chapter 1 and 2 Pub. 1942. 60¢

20% Discount to A.S.M.E. Members on all publications in this column.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Publication Sales Dept.
29 West 39th St., New York 18, N. Y.

TRACING CLOTH for HARD PENCILS



● Imperial Pencil Tracing Cloth has the same superbly uniform cloth foundation and transparency as the world famous Imperial Tracing Cloth. But it is distinguished by its special dull drawing surface, on which hard pencils can be used, giving clean, sharp, opaque, non-smudging lines.

Erasures are made easily, without damage. It gives sharp, contrasting prints of the finest lines. It resists the effects of time and wear, and does not become brittle or opaque.

Imperial Pencil Tracing Cloth is right for ink drawings as well.

IMPERIAL PENCIL TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE.

• Keep Informed

Changes in Taylor Instrument Cos. Personnel

Lewis B. Swift, President of Taylor Instrument Cos., has just announced four important changes in the personnel of the Sales Organization to take effect immediately.

Raymond E. Olson has been made General Sales Manager to head up all of the various sales activities, both domestic and foreign. Mr. Olson came with the Company in 1916 and after experience in both the Sales and Sales Engineering Departments became Manager of the latter in 1927. In October 1944, he was elected to the Board of Directors. During the war, Mr. Olson's department has played a large part in applying instruments to the difficult process control problems connected with the manufacture of synthetic rubber, 100-octane gasoline and many other products essential to the war effort. For several years he has served as director of the Dairy Industry Supply Association.

Succeeding Mr. Olson as Sales Engineering Manager will be Ralph E. Clarridge, who came with the Company in 1930 directly from Ohio State University where he received the degrees of Bachelor of Engineering Physics and Master of Science. While his activities have been concerned primarily with instrumentation problems in the oil and food industries, he has also served on the Development Committee of the Industrial Engineering Department.

Frank S. Ward, formerly Assistant Industrial Sales Manager, now becomes Industrial Sales Manager. He has been with the Company since 1917 and during this time has had a wide experience in sales work, both in the field and at the home office.

Assuming additional duties as Commercial Sales Manager is W. Maben Griffith, whose department has charge of the sale of such well known consumer items as household thermometers, barometers, compasses and medical instruments.

Bussmann and Granger Named Vice Presidents

At a meeting of the Board of Directors, A. G. Bussmann and L. D. Granger were elected Vice Presidents of the Wickwire Spencer Metallurgical Corp., it has been announced.

Mr. Bussmann is also Vice President in Charge of Sales of the Wickwire Spencer Steel Co. He has been associated with the Company since 1930 in various sales and administrative positions, including General Sales Manager.

Mr. Granger, prominent steel metallurgist and engineer, has previously been Assistant to the executive Vice President of the Wickwire Spencer Metallurgical Corp. He is also Vice President of and has long been associated with the American Wire Fabrics Corp., another Wickwire Spencer subsidiary.

Mr. Bussmann will continue to be located at the Wickwire Spencer Steel Co.'s executive offices, 500 Fifth Ave., New York 18, N. Y. Mr. Granger will be located at the Wickwire Spencer Metallurgical Corp. plant and offices, 260 Sherman Ave., Newark 5, N. J.

Link-Belt Announces Promotions

Edward J. Burnell, vice-president, Link-Belt Co., Chicago, announces the appointment of A. C. Fellinger to the position of sales manager, power transmission machinery, with headquarters at the company's Ewart plant in Indianapolis. This change is made to fill the vacancy caused by the untimely death of C. Walter Spalding.

Mr. Fellinger has had a wide experience in the field of power transmission, having joined

the Link-Belt organization at Indianapolis in 1916. His last position was manager of sales through distributors, with headquarters in Chicago.

The sale and application of Link-Belt silent chain drives will hereafter be headed up by H. F. R. Weber, divisional sales manager, silent chain drives, with headquarters at the Ewart plant in Indianapolis. Mr. Weber started his Link-Belt career at the company's Philadelphia plant in 1915 as a power transmission engineer, and last held the position of central division manager for power transmission machinery, with headquarters in Chicago.

G. H. Woody continues as sales manager of the ball and roller bearing division, with headquarters at the company's ball and roller bearing plant in Indianapolis.

Sales through Link-Belt distributors will be supervised by F. A. Hurd, divisional sales manager, industrial distributor sales, Chicago; G. H. Unruh, divisional sales manager, industrial distributor sales, Philadelphia; and Harry Reisser, divisional sales manager, automotive equipment sales, Indianapolis.

Republic Steel Elects Two Vice Presidents

The election of N. J. Clarke as senior vice president and J. M. Schlendorf, vice president in charge of sales, of Republic Steel Corp., was announced by T. M. Girdler, board chairman, and C. M. White, president, following the directors' meeting of the corporation.

Mr. Clarke has been vice president in charge of sales for Republic since September, 1930, shortly after the corporation was formed, and will be succeeded in that position by Mr. Schlendorf who has been assistant vice president in charge of sales.

Mr. Clarke started in 1897 with the Bourne-Fuller Co. as an office boy. Successively he became salesman and manager of the company's Pittsburgh office, and returned to Cleveland in 1912 as secretary and sales manager of the Upson Nut Co. which Bourne-Fuller had acquired.

His business career was interrupted by World War I when he was a major in the ordnance department. After the Armistice he returned to Bourne-Fuller as vice president and general manager and in 1919 Mr. Clarke organized and became president of the Lake Erie Bolt & Nut Co.

Mr. Schlendorf was with the American Sheet & Tin Plate Co. from 1905 to 1915. During the next two years he was assistant purchasing agent of the Willys-Overland Co. and in 1917 was named vice president in charge of sales of the Central Steel Co., Massillon, Ohio.

He continued in that position when Central Steel and the United Alloy Steel Corp. merged in 1926 to form the Central Alloy Steel Corporation. When that company became a part of Republic Steel Corp. in 1930 he was appointed manager of sales of the alloy steel division and in 1936 was made assistant vice president in charge of sales.

W. R. McLaughlin Made Sales Manager

A. J. Kerr, General Sales Manager of Pittsburgh Equitable Meter Co., has announced the appointment of W. R. McLaughlin as Sales Manager for the Gas Products Div. In his new position Mr. McLaughlin will direct the sales for Emco meters, regulators, and allied equipment for measurement and control.

Mr. McLaughlin has spent his entire business career in the gas and oil industry, having been associated with the Arkansas Natural Gas Co. for a period from 1919 through 1934 when he joined the Pittsburgh concern as a sales engineer. In this capacity he contacted a majority of the operating personnel in both gas and oil companies located in the six Southwestern states.

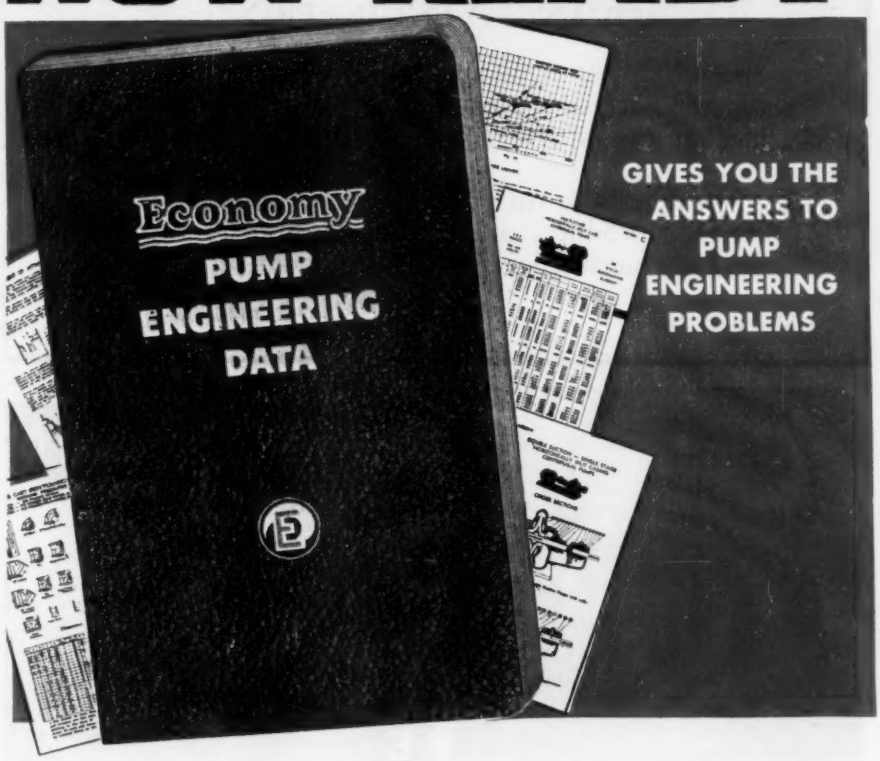
While connected with the Arkansas Natural Gas Co. his work was largely devoted to gas distribution, pipe line, and transmission activities which involved measurement and regulation. In 1928 he was made superintendent of the Gas Measurement Division for this utility.

Mr. McLaughlin is well-known for his work in furthering the interests of the Southwestern Gas Measurement Short Course, which is held annually at the University of Oklahoma, Norman, Oklahoma. He has served on numerous committees throughout the 22-year tenure of this school and was general chairman in 1934. He has also served at various times on the Gas Meter Committee of the American Gas Association, and the Gas Measurement Committee of the American Petroleum Institute.

He was one of a committee of eight selected from industry to assist the faculty of the Texas College of Arts and Industries, Kingsville, Texas, in establishing a course in natural gas engineering. For this participation he was awarded an Honorary Degree in

Continued on Page 42

NOW READY



A timely contribution to the pump industry—416 pages of factual data just when vital postwar problems require authentic facts, sound experience and advanced engineering practice.

Here, under one cover, are hundreds of handy tables and diagrams you need every day. Revised, improved and new data governing the correct layout and installation of sewage, drainage, processing, heating systems, etc. Describes clearly and exactly the way to do the job right.

Indispensable to Executives, Engineers, Plant Managers, Maintenance Men, etc. Sent free in response to requests on business letterheads.

If your copy is delayed in reaching you, we're sorry, and ask your indulgence. The unprecedented demand temporarily exceeded the manpower for handling—but all requests received to date are being filled in rotation.

ECONOMY PUMPS, INC.
HAMILTON, OHIO • U. S. A.
FOR OVER THIRTY YEARS MAKING BETTER PUMPS DO MORE

FRASER-BRACE ENGINEERING CO., Inc.

Design, construction and installation of complete plants and projects

Mechanical, Heavy Industries, Shipbuilding, Hydro-Electric Developments, Power Plants, Chemical and Refining Plants, Process Industries, Metallurgical Developments and Processes, Explosives, Plastics, Water Supply and Treatment, Sewage and Industrial Wastes Treatment.

• REPORTS • APPRAISALS • CONSULTING •

10 East 40th Street — New York 16, N. Y.

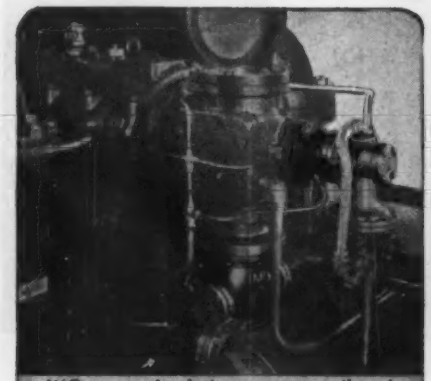
MECHANICAL RESEARCH COMPANY

ADVANCED ENGINEERING

Specializing in new development and design conception, requiring originality and exceptional mechanical experience and ingenuity.

Also undertake the redesign or simplification of existing products or machines, complete to the final production detail and assignment of patents.

100 Pearl St. — Hartford, Conn.



IMO pump circulating governor oil and lubricating oil for large turbine.

CROWDED? Install an IMO

The IMO PUMP requires less space than most other pumps because of the high capacity attainable by its efficient, compact design and high speed operation. If desired, it can be directly connected to, and mounted upon, turbines, motors, engines, or other equipment. In special designs, dimensions and proportions can be varied to meet space limitations. I-128

For further information send for catalog I-128-A

IMO

PUMP DIVISION OF THE DE LAVAL STEAM TURBINE CO.

TRENTON 2, NEW JERSEY

IRVING DECKING

BRIDGE FLOORING

OPEN STEEL GRID

SAFETY

Permanent Inwrought Traction Self-Cleaning Surface

LIGHTWEIGHT

Only 15¼ lbs. per sq. ft.

ECONOMY

Minimum Maintenance
Non-Erasible Lane Markers
Restores Old Bridges
Reduces Cost of New Bridges

May we send our catalog?

IRVING SUBWAY GRATING CO., INC.

ESTABLISHED 1902

HOME OFFICE and PLANT: 5010 27th STREET LONG ISLAND CITY 1, NEW YORK

WESTERN DIVISION: FOOT OF PARK AVE. EMERYVILLE 8, CALIFORNIA

• Keep Informed

natural gas engineering by the college in 1938.

Mr. McLaughlin is a member of the Petroleum Engineers' Club of Dallas; the Southern Gas Association, and the Independent Petroleum Association of America. He will make his home in Pittsburgh.

Robins Conveyors Reorganizes Sales Set-Up

In preparation for more intensive sales activity, Robins Conveyors Inc., Passaic, N. J., manufacturers of materials handling machinery, has reorganized its Sales Department, which continues under the direction of Harold Von Thadon, First Vice-President.

Under the new plan, E. C. Salzman, Vice-President, formerly in charge of sales assumes responsibility for all export operations, including dealings with foreign affiliates and agents. His headquarters will be at the 70 Pine St., New York, N. Y., offices of the company.

Moving to Passaic from the Chicago office, which was under his charge, J. F. Meissner, Vice-President, takes over control of all Engineering Sales and of the Field Engineers who devote their time and attention solely to matters involving the functions of designing and engineering materials handling projects and plants.

The Equipment Sales section is now under A. E. Conover, formerly Manager of the Vibrating Machinery Division. His responsibilities include the direction of that portion of the Field Engineering Staff who concern themselves with the sale of equipment, where little or no engineering is involved.

Sales Research and Training has been put under T. W. Matchett, Secretary of Robins Conveyors Inc.; Advertising and Sales Promotion remain under E. M. Perrin; the Engineering Dept. continues to be headed by R. W. Eichenberger, Vice-President.

A vastly expanded sales program has progressed beyond the planning stage and is being instituted as rapidly as additional personnel becomes available.

Roberts Appointed Allis-Chalmers Chattanooga Branch Manager

J. Warren Roberts has recently been appointed branch manager of the Allis-Chalmers office in Chattanooga, according to Frank Angle, manager of Allis-Chalmers district offices.

Prior to joining the Allis-Chalmers Atlanta district office in 1941, Mr. Roberts was employed by the Nashville Railway and Light Co., Tennessee Electric Power Co., Allied Engineers, Inc., and Electric Power Board of Chattanooga. Born in Soddy, Tennessee, in 1906, he attended Vanderbilt University and the University of Tennessee.

Mr. Roberts holds membership in the American Radio Relay League, Chattanooga Engineers club, and the Masonic Order.

Laclede-Christy Elections and Appointments

At a meeting of the Board of Directors of Laclede-Christy Clay Products Co. held July 24, 1945, John L. Cummings, Vice-President and General Sales Manager, was elevated to the position of Vice-President and Director of Sales and Julius A. Kayser was elected a Vice-President and made General Sales Manager.

Mr. Kayser has been with the Company for twenty-two years during which time he has gained a broad experience in the refractories field. He is a graduate engineer of The Royal Technical Institute of Copenhagen, Denmark, and has served the Com-

• Keep Informed

pany in the capacities of a Research Ceramist, Plant Superintendent, Divisional Sales Manager, Chief Refractories Engineer and Assistant Vice-President.

Harvey R. Hiller was appointed an Assistant Vice-President. He has been District Manager of the Chicago territory and now in addition to this territory, he is in charge of sales in the Wisconsin, Michigan, Northern Illinois and Indiana territories. He is a graduate engineer of Carnegie Institute of Technology and has been with the Company for twenty-two years.

John W. Rogers was also appointed an Assistant Vice-President. Mr. Rogers has been Sales Manager of the Glass Refractories Division and is continuing in that position. He is a graduate engineer of Massachusetts Institute of Technology and has been with the Company for twenty years.

Gilbert Soler Named Assistant General Superintendent

Gilbert Soler, Superintendent of the Quality Control Departments at Steel & Tube Division of the Timken Roller Bearing Co., has been named Assistant General Superintendent of the division, company officials announced.

Starting with the company in 1931 as a Refractories Engineer, Soler was made Manager of Research in 1934 and in 1937 was promoted to Manager of Research and Mill Metallurgy, which position he held until 1943, when he became Superintendent of Quality.

Soler attended elementary and high schools at Columbus, Ohio, and was graduated from Ohio State University a Bachelor of Ceramic Engineering in 1930.

He was awarded an Experiment Station Fellowship for graduate work leading to the Master of Science degree at the university the next year. In 1940, he received the Professional Degree in Metallurgical Engineering there.

A holder of several patents, Soler has written 18 papers on steel processing, refractories and allied subjects.

He served as chairman of the Canton-Massillon Chapter of the American Society for Metals in 1940 and 1941 and of the Refractories Division of the American Ceramic Society in 1941.

At present he is vice-chairman of the Iron and Steel Division Executive Committee of the American Institute of Mining and Metallurgical Engineers and a member of the Open Hearth Executive Committee, Electric Furnace Executive and Physical Chemistry of Steelmaking Committee of that organization. He is also active on several committees of the National Research Council.

AE Appoints Stoker Agent

American Engineering Co., Philadelphia, announces the appointment of the Mid-West Heat Service, 3336 Franklin Blvd., Chicago 24, Ill., to represent the AE-Taylor and AE Perfect Spread Stokers in northern Illinois and Indiana, including the Chicago Metropolitan District.

Wagner Added to Foxboro's Cleveland Staff

The Foxboro Co., Foxboro, Mass., maker of industrial instruments for measurement and control, announces the addition of Harry D. Wagner to its staff of engineers serving the Cleveland area. He has already taken up his new duties, with headquarters at the company's office, 417 Bulkley Bldg., 1501 Euclid Ave., Cleveland 15, Ohio.

Continued on Page 44

LASKER INTEGRATED FABRICATIONS

PLATE WORK
Tanks
Stacks
Flues
Breechings
Air Ducts
Hoppers
Chutes
Troughs
Pipe
Pressure Vessels

STRUCTURAL WORK
Equipment Bases
Special Frames
Building Steel
Platforms
Walkways

SKILL & SERVICE—INTEGRATED INTO YOUR JOB

A carefully planned integration of skill and service is what you really buy when you order Lasker Integrated Fabrications. The unit shown above is a typical example: it was designed, fabricated and erected for storing, conveying and mixing chemicals. The entire job, from general outline drawings to complete installation was handled by Lasker. Sheet metal, plate and structural steel work, machined parts and castings were all developed under a single responsibility—Lasker Engineering Co.—and erected to form the bucket elevator, chutes, bins, hoppers, and screw conveyors of this complete system.

Take advantage of this unique service! Write us, outlining your problems; we will review them promptly and make our recommendations. No obligation, of course.

LASKER ENGINEERING COMPANY

LE-6 17 EAST 42nd STREET NEW YORK 17, N. Y.

Mr. Wagner is well acquainted with industries in the territory, having spent much of his business career there. He has had extensive practical training in industrial instrumentation, having supervised the installation and operation of instruments in numerous plants, especially in the glass and rubber industries. His experience has also included the development of instrument departments and the training of personnel in instrument use and maintenance.

PROFESSIONAL SERVICE

In ALL BRANCHES of the ENGINEERING FIELD

Consulting Engineers
Engineering Organizations
Constructors—Contractors
Patent Lawyers, Etc.

Power Plants and Electrical Distribution for Industry
Surveys, Reports, Design, Construction, Supervision
EDWARD R. FEICHT
Bala-Cynwyd, Pa. (outside Philadelphia)

Mechanical Design—Product Design
Development of Products and Production Process Machinery
THE FRANCIS COMPANY
343 S. Dearborn Street, Chicago
Telephone: Harrison 7747

Chemical and Metallographical Laboratories—Welding . . Supervision, Inspection and Testing Qualification of Operators and Procedure
THE JAMES H. HERRON CO.
Cleveland, Ohio

Power Plants • New • Rehabilitation
Steam Generation — Diesel and Steam Power
Z. KOGAN
Consulting Service
CHICAGO

Weld Testing—Qualification of Operators—Supervision—Inspection—Research
NATIONAL WELD TESTING BUREAU
Pittsburgh Testing Laboratory, Pittsburgh, Pa.

Patents Obtained and Searched for any Invention in U. S. Patent Office—Confidential Advice—Literature
Z. H. POLACHEK
Reg. Patent Attorney — Professional Engineer
1234 Broadway (31 St.) NEW YORK
Phone: Longacre 5-3088

SANDERSON & PORTER
ENGINEERS
and
CONSTRUCTORS

Power Plants, Structures, Transmission Systems—Design, Supervision, Inspection, Appraisals, Reports.
SARGENT & LUNDY
140 S. Dearborn St., Chicago, Ill.

Power Plants, Public Utilities, Industrial Plants
WESTCOTT & MAPES, Inc.
Architects and Engineers
New Haven, Conn.

RATE **Announcements under this heading in MECHANICAL ENGINEERING are inserted at the flat rate of $1.25 a line per issue, $1.00 a line to A.S.M.E members, minimum charge, three line basis. Uniform style set-up. Copy must be in hand not later than the 10th of the month preceding date of publication.**

Diesel Equipment Company of Memphis Appointed Briggs Distributor

Diesel Equipment Co., 308 South 2nd St., Memphis, Tenn., has been appointed Distributor for Briggs Clarifier Co. of Washington, D. C. and Bethesda, Md., pioneer manufacturers of industrial and marine oil filtration equipment.

The territory assigned includes Western Tennessee and Northeastern Arkansas and portions of Southeastern Missouri, Southern Illinois, Southern Indiana and Southern Kentucky.

Principal trading centers in this area include Nashville and Memphis, Tennessee; Evansville, Indiana; and Paducah, Kentucky.

Worthington Brown and William F. Fay who jointly own and manage the firm have had many years experience in the distribution and servicing of industrial products. They are intimately acquainted with the territory assigned to them. They are fully equipped to give prompt and efficient service to present and future Briggs customers.

C. L. Williams Is Added to Foxboro's New York Staff

The Foxboro Co., Foxboro, Mass., maker of industrial instruments for measurement and control, announces that Mr. Clarence Leslie Williams has joined its staff of sales engineers whose headquarters are in the company's New York office, 420 Lexington Ave. He has been assigned to the northern New Jersey territory and has already entered upon his new duties.

Mr. Williams is thoroughly at home in this area, being a native of New Jersey and a graduate of Stevens Institute of Technology, at Hoboken. A broad background of diversified business experience has equipped him for capable and efficient assistance to Foxboro customers in any problem of industrial instrumentation.

Federal Products Texas Representative Moves

E. L. Stacey, southern Texas representative for Federal Products Corp., manufacturers of Dial Indicators and Dial Indicator Gages, including Foote, Pierson Electronic Gage, and the Metricator Air Gage; all for inspecting linear dimensions, has moved his office from 3022 Houston Avenue, Houston 9, Texas, to 2148 Dryden Road, Houston 5, Texas.

Paul Moore Joins Star as Motor Sales Manager

Appointment of Paul J. Moore as Motor Sales Manager of Star Electric Motor Co., Bloomfield, N. J. has been announced by Ivor M. Peterson, Vice President and General Sales Manager of the company.

Mr. Moore has been Sales Manager of Imperial Electric Co., Akron, since 1944 when he left the General Electric Co., Schenectady, after many years in the Motor Division. He is a graduate electrical engineer, Syracuse University, Class of 1923.

Samuel C. Alexander Reopens Foxboro's Charlotte Branch

The Foxboro Co., Foxboro, Mass., maker of industrial instruments for measurement and control, announces the reopening of its branch office at Charlotte, N. C., closed in October, 1942, because of war conditions. Samuel C. Alexander, 2012 East 7th Street, is the resident engineer in charge.

Although serving industries of every kind, Mr. Alexander is particularly qualified, by long experience, to handle the instrument problems of the textile industry. In his 23 years with the Aberfoyle Manufacturing Co., he served as yarn technician and field service representative in North and South Carolina, and developed a wide acquaintance with mill men, their equipment and their problems.

Mr. Alexander, a past president of his Rotary Club and member of several civic and fraternal organizations, has already taken up his new duties in Charlotte, where he and Mrs. Alexander and their children are now settled.

Wickwire Spencer Names Sidney E. McCrum Assistant Advertising Manager

C. B. Konselman, Advertising and Public Relations Manager, Wickwire Spencer Steel Co., announced today the appointment of Sidney E. McCrum as Assistant Advertising Manager.

Mr. McCrum was previously Assistant to the Advertising Manager of the Chicago Pneumatic Tool Co., New York. He has had extensive experience in advertising preparation and production.

Currently Wickwire Spencer's advertising program includes general and trade magazines and newspapers. A greatly expanded sales and merchandise program is planned for postwar.

W. J. Sommers, Appointed Distributor for Western New York State and Northwestern Pennsylvania

The Briggs Clarifier Co., Washington, D. C., manufacturers of industrial, automotive and marine oil filtration equipment, has announced the appointment of W. J. Sommers, 505 Delaware Avenue, Buffalo, New York, as Distributor covering Western New York State and Northwestern Pennsylvania.

Widely experienced in the distribution of industrial products, Mr. Sommers has a thorough knowledge of the territory. His firm is organized to give prompt and efficient service to all Briggs present and prospective customers.

McLaughlin Joins Carrier

R. W. McLaughlin has joined Carrier Corporation as Assistant Director of Development in charge of the heavy machinery engineering section according to an announcement by Herbert L. Laube, Vice President of the Corporation.

Mr. McLaughlin's chief assignment has to do with supervision of design and development for centrifugal compressors used in large refrigeration and air conditioning installations.

Prior to joining the Carrier organization, he was chief engineer of the blower and supercharger division of the Elliott Co. in Jeanette, Pa.

A frequent contributor to engineering journals, Mr. McLaughlin has authored numerous articles for such magazines as Power Plant Engineering, Industry and Power, and the S.A.E. Journal. He is a registered professional engineer for the state of Pennsylvania and a member of the Society of Automotive Engineers.

After his graduation from Iowa State College with a B.S. in Mechanical Engineering, Mr. McLaughlin was associated for a period of years with General Electric in Schenectady in the large turbine engineering department.

• Keep Informed

G. E. Establishes Million Dollar Marine Warehouses at New York and San Francisco

Warehouse stocks of more than $1,000,000 worth of replacement parts have been established at New York City and San Francisco as part of a new marine service established by General Electric, according to an announcement by R. S. Neblett, manager of the Company's Federal and Marine Divisions.

First of its kind, the new servicing arrangement will permit maintenance and most overhaul jobs on propulsion or other operating equipment to be taken care of while a ship is being unloaded and refilled with cargo, Neblett says. The servi e has been established primarily for the high-efficiency C-type ships and turbine-electric drive tankers built during the past eight years under the U. S. Maritime Commission program, some 40 per cent of which have been equipped with G-E geared-turbine or turbine-electric propulsion sets.

At New York, the new service is under the supervision of R. A. Williamson, G-E marine engineer there. George Barr, marine supervising engineer for G. E. on the West Coast, has charge of the service at San Francisco. New waterfront warehouse facilities have been obtained and stocked at both cities.

"Fast turnaround is going to be more important than ever to profitable shipping in the postwar period," Neblett said. "A primary purpose in setting up our new servicing arrangement is to keep G-E equipped ships of the U. S. Merchant Fleet operating at top efficiency in the busy days ahead."

Neblett pointed out that two or three weeks was average time for ship maintenance and servicing in the past. Normal delays in getting needed parts out of shops concentrating on production of complete equipments, and delivering the parts to the point where they were needed usually required about that much time. Under the new servicing plan, parts required for servicing G-E marine equipment will be available to east and west coast ports on an off-the-shelf basis. The million-dollar warehouse stocks range from small electrical and mechanical parts up to 30-ton turbine rotors, and powerful generators. The stocks will be continuously replenished as needed.

McGuire Represents K. O. Lee

K. O. Lee Co., manufacturers of Machine Tools and Automotive Maintenance Equipment, Aberdeen, South Dakota, announce the appointment of M. C. McGuire, 613 Lafayette, Ionia, Mich. as our factory representative in the state of Michigan.

Leidy Appointed Westinghouse Manager

Appointment of H. B. Leidy as manager of the Middle Atlantic District Manufacturing and Repair Department of the Westinghouse Electric Corp. has been announced by H. F. Boe, Vice President.

Mr. Boe also announced that R. J. Miller, who had been acting manager of the department, has been transferred to Emeryville, Calif., as assistant manager of the Pacific Coast District Manufacturing and Repair Department, and that H. E. MacArthur, formerly foreman of the Newark, N. J., M. & R. plants, has been made manager of the Huntington, W. Va., branch.

Mr. Leidy is a native of the Keystone state, having been born at Wallaceton, Pa., in 1899. He attended Sunbury High School and studied engineering at Bucknell University

Continued on Page 46

Get to know

VAN DYKE WEATHERPROOF

– the All-weather Colored Pencil with Insoluble Lead!

Weatherproof Van Dyke Colored Pencils never fail to make a satisfying first and lasting *impression.* Sturdy, easy-to-sharpen insoluble lead guarantees greater Pigment-to-Paper Writeability. . . top legibility in 24 brilliant colors. Perfect for charts, drawings –or whenever you need *moisture proof marks.*

SOLD IN SOLID COLORS OR IN 12 OR 24 COLOR EASEL-BOXED ASSORTMENTS

IT'S MADE BY

EBERHARD FABER

Leadership

IN FINE WRITING MATERIALS SINCE 1849

before obtaining a commission in the United States Army in 1917.

He joined Westinghouse in 1920, and served as a field engineer, salesman, branch manager at the Wilkes-Barre Manufacturing and Repair Department, and from November 1942 to June of this year, was assistant manager of the department he now heads.

In his present position, Mr. Leidy will be responsible for the repair activities and operation of plants located in Philadelphia, Baltimore, Wilkes-Barre and Huntington, W. Va. These plants manufacture steam turbines, switchgear and control, radio apparatus, and other special equipment for the Army and Navy.

Mr. Leidy, who is a member of the American Institute of Electrical Engineers, has served as a commander of an American Legion post and he held a similar office in the Society of the 28th Division of the American Expeditionary Forces.

• LATEST CATALOGS

"Heli-Coil" Spark Plug Bushings

Aircraft Screw Products Co., Inc., 47-23 35th St., Long Island City 1, N. Y., has just issued Bulletin No. 237-A which illustrates and describes their "Heli-Coil" Spark Plug Bushings.

The use of "Heli-Coil" Screw Thread Inserts as 14 and 18 mm. Spark Plug Bushings is one of the most important applications of this relatively new product. Bulletin No. 237-A tells of the advantages of "Heli-Coil" Spark Plug Bushings as opposed to various other types of installations—contains data on assembly and servicing—gives details on a typical installation.

Rotometer Monograph for Steam

Fischer & Porter Co., 97-S County Line Road Hatboro, Pa. have available a monograph for determining the correct rot meter size for steam measurement which is an invaluable guide to rotometer selection.

New Tinnerman Brochure

Now available, the new Tinnerman brochure just off the press illustrating a wide variety of new spring tension Speed Nuts and Speed Clips for automotive assemblies. This is the new Tinnerman Brochure No. 200 featuring faster vibration proof fastening methods for head lamps, tail lamps, molding, medallions, insulation, glove boxes, doors, handles, knobs, instrument panels, hose connections, fenders, hoods, grills, mufflers, tail pipes, cables, brake drums, horns, accelerators, spark plugs, seats and radio. It is a twenty-four page book fully illustrated. Produced by Tinnerman Products, Inc., Cleveland, Ohio.

Heavy Duty Forgings

For quite a number of years the National Forge & Ordnance Co., Irvine, Warren County, Pa., has been mailing out their Date Book each month. But many of those who have received the Date Book have not had an opportunity to visit their plant.

Now, they have available a booklet entitled "Why Heavy Duty Forgings Should Be National Forged." This booklet is designed to take one through their plant without being taken away from their desk. They have endeavored to convey a picture of the facilities available and the variety and sizes of the products made.

This new booklet, "Why Heavy Duty Forgings Should be National Forged" will give a broader knowledge and understanding of the service they are prepared to render.

Cold Water Deaeration

Corrosion is one of the most destructive forces of nature and water when heated to relatively high temperature may cause severe corrosion and deterioration of steel pipelines, equipments, etc.

Cochrane Corp. has developed a deaerator for the purpose of removing oxygen and carbon dioxide from process waters used cold. This removal of oxygen and carbon dioxide will prevent corrosion action and thus give protection to equipments, eliminating maintenance and absolescence.

The manner in which this is accomplished is described in Cochrane Reprint 43 "Cold Water Deaeration," which is free for the asking. Address Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia 32, Pa.

New Booklet Describes Haynes Stellite Metal-Cutting Tools

A new catalog, "Haynes Stellite Metal-Cutting Tools," which describes the high-production metal-cutting tools made from Haynes Stellite 98M2 and Star J-Metal alloys, has just been published by Haynes Stellite Co., a Unit of Union Carbide and Carbon Corp.

The catalog includes descriptions, illustrations, engineering drawings, specifications,

CASH PRIZES

TRIPS TO MEXICO

ART SCHOLARSHIPS

$250 cash or all-expense Mexican trip, plus having their work considered for a scholarship at the Chicago Academy of Fine Arts, American Academy of Art, Internat. Correspondence Schools, Art Instruction, Inc., and other schools is one of the many awards offered students under 21, in the 3rd Annual JUSTRITE Drawing Ink Contest.

Also, there are three all-expense trips to the beauty and cultural spots of Mexico for TEACHERS of the students entering the contest. Teacher awards are based on student participation.

Get full details, JUSTRITE Ink and entry blanks from your school supply or office supply dealer. Contest closes April 20, 1946.

Louis Melind Company

362 W CHICAGO AVENUE - CHICAGO 10, ILL.

NEW YORK DETROIT LOS ANGELES SAN FRANCISCO

FLEXO JOINTS

—wherever a flexible or swing pipe joint is required.

FLEXO JOINTS are used everywhere in industry to convey steam, compressed air, gas, water, oil and other fluids through pipe lines that must be moved or swung in different directions or to supply machinery or equipment with any fluid while in motion. Simplicity is one of the outstanding features of **FLEXO JOINTS** as there are no springs to lose or ground surfaces to wear. They are ruggedly constructed for long, hard service and will outlast the pipe to which attached. The initial cost is nominal; the maintenance cost is negligible. Made in 4 styles and for all pressures to 1350 lbs. superheated steam. Standard iron pipe sizes from ¼ inch to 3 inches.

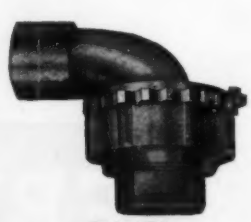
Write for bulletin

FLEXO SUPPLY COMPANY Inc.

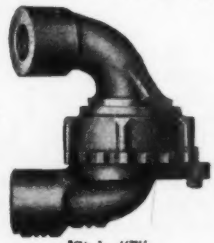
4219 Olive Str. St. Louis (8) Mo.

In Canada:

S. A. Armstrong Ltd. 115 Dupont Str. Toronto (5)



Style "B"



Style "F"

• Keep Informed

and prices for standard tools manufactured by the Company. Among the tools discussed are square, rectangular, and round tool bits; boring and reaming blades; tipped tools and tool tips; grooving tools; cutoff tools; insert milling cutter blades; shell end mills; wear strips; and special tools. To aid those using Haynes Stellite tools, the booklet includes recommendations for cutting angles, speeds and feeds for turning, boring and milling various plain and alloy steels, cast steel and cast iron, stainless steel, bronze, brass and aluminum. Full recommendations are also included covering paper grinding, brazing and silver soldering techniques.

The attractive 52-page booklet is conveniently punched for binding, and is completely indexed for convenient reference. Copies are available without charge or obligation from the general offices of Haynes Stellite Co., Kokomo, Indiana.

Introduction to Electronics

To provide an understanding of the principles of electronics and an idea of the part electronics will play in future industrial developments, a 20 page book entitled, "Introduction to Electronics," has been produced by the Allis-Chalmers Mfg. Co. The new educational bulletin was prepared by Dr. Walther Richter, recognized as one of the outstanding engineers in this promising electrical field.

A brief discussion on the fundamentals of conversion and control of electric power in a load prefaces introduction of the subject of electron tubes. Approaching this subject as a guide for application engineers, instead of tube designers, the book explains that the electron tube is a new control element which is nothing but a special type of rheostat or switch. The discussion of tubes is divided into two main parts: vacuum and gaseous.

Differences between a vacuum tube and the equivalent mechanical device, methods of specifying tube performance, application of tube characteristics for design purposes, and use of the high speed response of the tube are explained. Clearly presented are principles of tube detector action with applications, and principles of tube oscillators with application to induction and dielectric heating. Line drawings, curves, and sketches add materially to comprehension.

This booklet, E6358, is available upon request from the Allis-Chalmers Mfg. Co., 568, Milwaukee 1, Wis.

Pressure Safety Appliances

Information Bulletin 502-A—a condensed catalog of Longergan safety valves, relief valves, pressure gauges, and specialties. Lists essential specifications in tabular form. Illustrates principal design types. Information given to facilitate selection. J. E. Lonergan Co., 2nd & Race Sts., Philadelphia 6, Pa.

Permanent Mold Castings

Written to provide designing engineers, production executives and metallurgists with reliable information on permanent-mold-castings, a new Reference Data Bulletin PMC 45 has recently been published by The Permold Co., Medina, Ohio.

This 20-page two-color review of permanent-mold-castings points out advantages obtainable with aluminum castings with respect to such matters as cost, design and strength. Suggestions are offered to the designing engineer to facilitate the designing of parts for the permanent-mold casting process.

Continued on Page 48

ADD PRESSURE SEAL

to quicker fit...

THIS MAY BE NEWS to you ... You can get all the advantages of Laminum *plus* the sealing of oil and pressure in bearings ... in *babbitted* Laminum shims. The babbitt lugs are securely locked into the Laminum. Details on request.

Laminum shims are cut to your specifications. For maintenance work, however, shim materials are sold through industrial distributors.

Laminated Shim Company, Incorporated
Union Street • Glenbrook, Conn.

LAMINUM
THE SOLID SHIM THAT peels FOR ADJUSTMENT

• Keep Informed . . .

The booklet includes four tables which give the nominal composition and physical properties of Permold aluminum base alloys and the nominal composition and physical properties of Permold aluminum base sand cast alloys. Herein is contained valuable information on how to achieve sound casting quality.

Various applications of permanent-mold-castings are illustrated by clear-cut photographs of many varied parts.

This booklet is especially desirable in that it offers clear-cut methods for obtaining the lowest piece price for each part at the point of assembly.

Modern Governors for Large Hydroelectric Units

A 24-page bulletin (B6356) on centralized control provided by modern governors for large hydro-electric units has just been released by the Allis-Chalmers Manufacturing Co., Milwaukee, Wisconsin.

Fully illustrated with governor and related hydraulic-turbine equipment photographs, diagrams, and figures, the bulletin defines the functions of governors and describes set-ups for Francis, Kaplan, and Pelton turbines.

Described in detail are Allis-Chalmers hydro-electric applications and governor arrangements at the Pickwick Landing plant, Kentucky power plant, Wilson Dam, and the Fontana plant of the Tennessee Valley Authority; the Alcoa Glenville plant of the Natahola Power & Light Co.; and the Interior Department's Shasta Power plant.

For hydro-electric installations like this, the company manufactures not only the three types of hydraulic turbines and their governors but also generators, transformers and switchgear equipment.

The bulletin concludes with a four page discussion of "Governor Operation in Practice" and a "Comparison of Governor Characteristics."

Feed Water Regulators

An 8-page Bulletin, No. 83-C, entitled "Bailey Thermo-Hydraulic Feed Water Regulators" has been issued by Bailey Meter Co., Cleveland 10, Ohio. It describes and illustrates improved designs of thermo-hydraulic generators and bellows operated feed water regulator valves, suitable for feed lines ranging in size from $^3/_4$" to 6" inclusive.

A full page colored schematic illustration demonstrates the thermo-hydraulic principle which is entirely self-contained requiring no outside source of power.

Dimensional Quality Control Primer

Federal Products Corp., Providence 1, R. I., announces a new booklet, the Federal Dimensional Quality Control Primer, which they offer free to any concern considering the use of Quality Control methods, or which has decided to establish Statistical Quality Control methods in their plant.

There has been a great deal of interest in Statistical Quality Control in the past few years. It is a subject which has been received with some doubt and fear because it seemed to be so theoretical and complicated, and yet it is an inspection tool which can, and should, be used more frequently. It has needed simplifying the same as many other tools have needed simplifying after their original conception

An insert, which is furnished with each Primer, explains its purpose and scope.

The Work and Chart sheets, samples of which are enclosed in each Primer are available from Federal Products Corp. This is important because there are no standardized sheets of this kind available for the trade. Every plant has to either print up its own or buy co-ordinate paper and adjust it to their needs. Prices are as follows: $6.00 per thousand for Chart Sheets and $2.50 per thousand for Work Sheets. Large quantities over ten thousand at special prices.

A New Era in Flow Rate Measurement

Fischer & Porter Co. offers the third, revised edition of "A New Era in Flow Rate Measurement", which discusses and illustrates the advantages of the rotameter for flow rate measurement. You will find these 32 pages interesting reading and yet the most informative material you have yet encountered on rotameters and their applications. Each basic advantage of the rotameter—its extremely high accuracy—its linear flow curve—its wide flow range—the ready visibility of the metering elements and fluid—the immunity of the Fischer & Porter Ultra-Stablvis rotameter to variations in viscosity and specific gravity—and other advantages are clearly discussed and extremely well illustrated.

The busy executive or engineer can read this absorbing catalog in about 15 minutes time. For a free copy of Catalog 10-C write Fischer & Porter Company, 9707-C County Line Road, Hatboro, Pa.

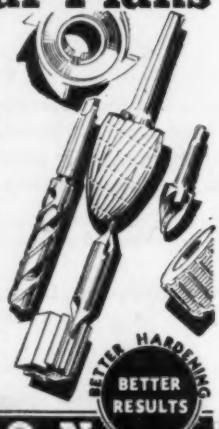
In Your Post War Plans

Why not decide to get more and better work out of tools to meet keen competition? Take advantage of treatments available here which often improve tools 30% to 60% or more. We have specialized in tool treating for a quarter-century. The war has brought new and better methods for original hardening, and also for supplementary treatings of tools purchased in hardened, finished condition.

Now is the time to investigate. Let us show you how other manufacturers have already benefited. More than half of the tools now in common use can be treated so they will run longer between grinds, hold size better, and produce a smoother finish.

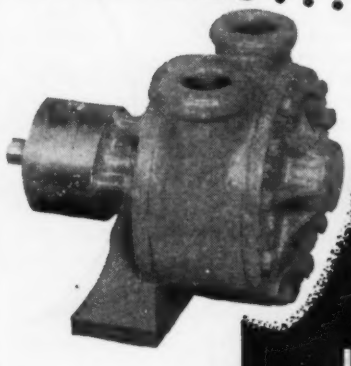
Our "SILVER FINISH" is bright, clean hardening.
Our "NUSITE" means harder, tougher cutting tools.
Our "AD-LIFE" improves the tools you buy outside.

Write for booklet, "FIFTY FACTS"—It tells what other manufacturers did to improve tool quality and life.



PERFECTION
TOOL & METAL HEAT TREATING CO.
1740-58 WEST HUBBARD STREET CHICAGO 22, ILL.

WHEN YOU NEED PRECISION-BUILT SMALL PUMPS . . . Specify TUTHILL



For High Pressure Service . . . IT'S MODEL CK

For machine tools, engines and hydraulic mechanisms, Tuthill Model CK high pressure pump offers dependable performance in a compact package. This internal gear rotary pump is designed to save space, material and money. Sizes from 1 to 50 g.p.m. Pressures up to 400 p.s.i. Direct motor drive, V-belt units and integral drives. Write for Model CK bulletin.

Serving Army • Navy
Air Force • Merchant Marine

TUTHILL *Pump Company*
939 EAST 95th STREET
CHICAGO 19, ILLINOIS